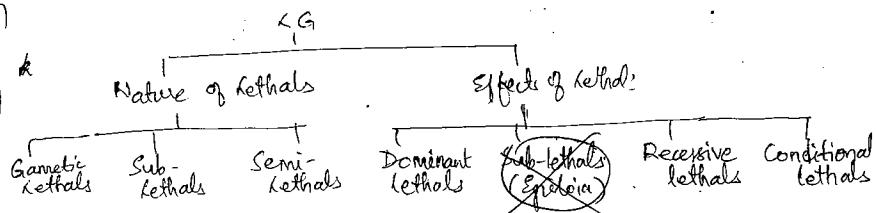


Lethal genes → A mutated gene that causes sudden (or) delayed death from an micron is called a Lethal gene.

It was first discovered in mice (Yellow coat colour).



combination of multiple environmental and genetic factors determined the phenotype of an individual.

Multiple Factor Hypothesis readily explains three features of quantitative traits:

1. The multiplicity of factors contributing to a trait accounted for the variability among phenotypes. This variability arises from the large number of genotypes and environments that are possible when many factors are involved.
2. Fisher's hypothesis suggested an explanation that if a trait is influenced by two types of alleles, plus and minus, defined according to whether they add or subtract an effect, Mendelian segregation should lead to many individuals carrying a mixture of plus or minus. Thus, extreme values of the trait should be rare, whereas intermediate values that are close to the mean should be common.
3. Fisher's principle explains why offspring of crosses between phenotypically different parents often had intermediate phenotypes. One parent might have a large number of plus alleles; the other a large number of minus alleles, and their offspring would have a mixture of both types. Such offspring would therefore be expected to be phenotypically in between the parents.

LETHAL GENE ACTION

① ✓ One of the most important, but rarely stated, assumptions for a discussion on inheritance of any trait is the equal survival of all the gametes and zygotes produced as a result of segregation. This assumption is fulfilled in case of a majority of the genes. But some genes affect the survival of those zygotes or individuals in which they are present in the appropriate genotype. The effect of various genes on survival ranges from an increase in survival, through no effect to death of all individuals carrying the gene. Genes can be categorized into five types based on their effect on survival - Lethal, Semi-lethal, Sub-vital and Super-vital genes.

• Lethal Gene: A lethal gene is a gene that causes death of all the individuals carrying this gene in the appropriate genotype before they reach adulthood. The appropriate genotype for an allele would depend on its dominance relationship with its other allele (s). The stage of development at which a lethal gene produces its lethal effect varies considerably from one gene to the other - some cause death very early in development while others allow survival and development close to the reproductive age - E.g., Epiloia in man. Lethal genes can further be classified into Recessive lethals, Dominant lethals, Conditional lethals and Gametic lethals.

○ Recessive Lethals: Most of the lethal genes are recessive lethals. Their lethal effect is expressed only when they are in the homozygous state. The survival of the heterozygotes is unaffected. However, many other genes are known that have a dominant phenotypic effect in case of heterozygosity, but are recessive lethals - E.g., Achondroplastic Dwarfism and Xeroderma pigmentosum (producing heavy freckles in heterozygotic condition). Other genes are also present which are recessive both in their phenotypic as well as lethal effects. In such cases, the heterozygous individuals have normal phenotype as well as normal survival and they cannot be differentiated from normal homozygotes. The lethal genes described so far reduce the survival of zygotes that carry them in the appropriate genotype - such lethals are called zygotic lethals and constitute a vast majority of lethal genes.

○ Dominant Lethals: These lethal genes reduce viability in the heterozygous conditions as well e.g., Epiloia in man - this gene causes abnormal skin growths, severe mental defects and multiple tumours in the heterozygotes so that they die before reaching adulthood. Hence, dominant lethals cannot be maintained in the population while the recessive lethals are maintained in the heterozygous state. Dominant lethals have to be produced in every generation through mutation.

(iii) Some Lethal genes Because of delayed onset of some lethal genes, they are passed on to offspring.

Characteristics of Quantitative traits

- (i) Effect of each allele contribution is cumulative
- (ii) Each allele have equal effect
- (iii) No dominance involves
- (iv) No Epistasis exists

Anthropology Paper 01 - Volume 01

(v) Intermediate phenotype are numerous than extremes

(vi) Serves as basis for racial classification

Eg.: hair colour

- Both lethal & sub-lethal genes may be dominant (or) recessive. (in early infancy or childhood)

Semilethals - Genes which kill the possessor after attaining reproductive age
Ex:- Huntington's disease (after 40 yrs)

Anthropology Paper 01 - Volume 01

○ **Conditional Lethals:** Some lethal genes allow normal development and survival, except under a specified condition that is necessary for their lethal effect. Such lethal genes that require a specific condition for their lethal action are termed as conditional lethals. E.g., some lethals require environment conditions like temperature, light, nutrition. Xeroderma pigmentosum in man - light and Phenylketonuria - nutrition. All the conditional lethals require specific genetic environment.

○ **Gametic Lethals:** Some genes lead to inviability of gametes or make them incapable of fertilization; such genes are termed as gametic lethals. Gametic lethals lead to a drastic departure from the typical ratio expected in a segregating generation - this phenomenon is called segregation distortion or meiotic drive.

• **Semi Lethal Genes:** Semi lethal genes do not lead to the death of all the individuals that carry them in the appropriate genotype. However, they cause the death of more than 90% of the individuals; only less than 10% of the individuals survive.

• **Sub Vital Genes:** These mutant genes reduce viability of the individuals carrying them in the appropriate genotype as compared to that of the normal individuals. Such genes kill less than 90% of the individuals in which they are present.

• **Vital Genes:** These genes do not affect the survival of the individuals in which they are present. These genes neither enhance nor reduce the viability of the individuals carrying them. It does not imply that these genes are not necessary for survival of the concerned organism - it simply means that the survival of the organism is not affected by the fact that the concerned vital genes are present in homozygous or heterozygous state.

• **Super Vital Genes:** These mutant genes enhance the survival of those individuals that carry them in the appropriate genotype as compared to that of the wild type allele. Genes for disease resistance in a crop species may be regarded as super vital genes as they protect the individuals carrying them against the concerned disease and thus increase the chances of their survival in the presence of concerned disease.

- Davenport studied skin colour in humans.

Continuous Variation

Ex:- skin colour studies showed 5 phenotypes in ratio of 1:4:6:4:1

Assume skin colour affected by 2 genes - AAB_B

phenotype	Black	white
Genotype	AAB _B	aabb

AB ab

Many intermediate variations in above ratio

① Quantitative characters can be measured by mean, median, mode

② Measures of dispersion

↳ Mean dispersion

↳ Coefficient of variation

↳ Standard deviation

↳ Quartile deviation

↳ Range

Examples of needed

(Single factor)

Qualitative

Only by genes

can be identified easily

① Traits influenced by both genes & envt

② Single gene defect can't be detected

③ Continuous variation

④ No easy classification

⑤ Analysis can be done by statistical method

⑥ Biometrical characters (ex)
Polygenic characters

Ex:- Height & Weight

All (or) none characters

Blood groups

9.3 CONCEPT OF GENETIC POLYMORPHISM AND SELECTION

Genetic Polymorphism: Individuals in a population differ in different counts. There might be purely environmental differences like the person's language, there might be purely genetic differences like the blood type, or there might be differences due to interactions between heredity and environment, like the person's intelligence.

Usually phenotypic variations, i.e., the morphological variations are considered to be genetic variations. But, this is not true in all the cases. In fact, genetic differences far outweigh phenotypic variations. Many genetic variations are concealed at the levels of DNA, or Chromosome of the cells and are not necessarily expressed as phenotypic variations which are amenable to direct observation. This variation in a population in the genetic material is generally termed as Genetic Polymorphism.

3 Polymorphic traits are discrete and discontinuous genetic characters which are controlled by single genes and are less influenced by environmental factors. These polymorphic traits are different from those phenotypic traits which are graded or continuous variations that are controlled by many genes and are strongly modified by environment. An example for the earlier case is the ability to taste PTC and for the latter case, the height and skin color of a person.

The populations which are characterized by individuals with discrete, discontinuous genetic traits are said to be polymorphic and those which lack such individuals are said to be monomorphic. A population with both tasters of PTC and non-tasters for PTC is said to be polymorphic and those with only the tasters or only the non tasters is said to be monomorphic. The concepts of polymorphic or monomorphic populations can be applied to both the genotype as well as the phenotype.

Definition: Genetic polymorphism can be defined as the occurrence of more than one morph (a gene) in a population. In order to be classified as genetically polymorphic trait, a character must be present in a frequency greater than 1%. If it is present in a frequency below this level, it is supposed that it is arising due to mutation and selection is not operating on it. It is only above the ratio of 1% that we can be sure to say some selection is involved in its maintenance and it is not because of recurrent mutations.

Source of Genetic Polymorphism: Any population is not entirely dependent on mutation for genetic polymorphism to develop, though it is the ultimate source. A small rate of mutation cannot maintain the observed genetic polymorphism in a population. The supply of genetic polymorphism upon which natural selection acts, is provided by a variety of genetic combinations built up over many generations by the flow of genes from other populations, the migration, genetic recombination and as a result of interaction between mutations and natural selection. Thus, genetic polymorphism can be brought about by activity of many factors.

Levels of Genetic Polymorphism: Genetic polymorphism can be seen in different levels of the heredity material of the population. It can be seen at the level of the cell, DNA, Proteins, Chromosomes, etc. At the cellular level, we can consider the polymorphism of the antigenic molecules. For example, the antigens in the human ABO blood systems are polymorphic. There can be four conditions for this antigen complex - A, AB, B, and O. Chromosomes have a capability to undergo rearrangements. These include deletions, insertions, additions, inversions and translocations. These rearrangements usually characterize differences in the chromosomal behavior and can also provide adaptive advantages to the populations housing them. There are also instances of chromosomal fusions. Different types of chromosomal rearrangements may involve drastic shifts in the character manifested, thus providing opportunities to agents of selection to act and effect major evolutionary consequence.

Genetic polymorphism can also be seen at the level of protein molecules. There are many instances where there are structural differences in the molecules of proteins. These polymorphic proteins also might provide an adaptive advantage to the populations having them. Similar is the case with certain enzymes.

GENETIC POLYMORPHISM AND SELECTION

Most of the inherited differences in human beings represent differences in the structure of DNA. These differences in the DNA are due to the changes in the sequence of bases. It has been found out that all such differences in the DNA may not be important for natural selection to act to affect Darwinian fitness. However, too much of genetic variation or polymorphism might increase the effect of genetic load and the latter is responsible for thinning of the population. Due to the excess presence of genetic polymorphism, the average fitness rate of the population might get affected.

According to Kimura, the vast genetic polymorphisms at the gene and protein level involve only alteration of structure, being equivalent at functional level. Such variants, being functionally equivalent, would respond similarly to selective forces. Such polymorphisms are referred to by Kimura as "Selectively Neutral" polymorphisms.

Contrarily, for some other scientists, polymorphisms have a selective basis and might be useful in some way for different shades of environment. It is also useful for inbreeding and prevents a gradual build up of homogeneity in the population which is considered to be deleterious. According to these scientists, genetic polymorphism is very advantageous to the population and hence is not Selectively Neutral as according to Kimura.

Moreover, certain characters in the population are more or less permanently polymorphic. Sex is one such polymorphic feature. Stable polymorphic features are maintained in the population by stabilizing natural selection. Stabilizing selection removes from the population those individuals that deviate from the population mean. Thus individuals not perfectly male or female are removed from the population so that population shows only two discrete individuals with reference to sex - male or female.

Polymorphism may be in a transitory phase in the sense that certain populations with shifting environmental demands shift their population for some character in the direction of environmental change. At a time when one form has not replaced the other completely, a polymorphic population may exist. But gradually over the time this transient population may be replaced by monomorphism by directional natural selection.

Natural selection prefers heterozygotic condition when it considers them to be superior to the homozygotes. Polymorphism provides a population with alternative set of traits of a character. In a stable environment it may be of little significance. But under conditions when the environment is changing, populations with different polymorphic traits can explore for an adaptive advantage. A majority of polymorphic traits exist in the human populations. Most of their potentialities can only be assessed in the future environments.

MENDELIAN POPULATION

The term "Population" means different things to different persons. In its dictionary sense, the term implies a collection of times. To a biologist, it is an aggregation of similarly adapted organisms. A geneticist uses the term to signify a "spatial - temporal group of conspecific (i.e., belonging to the same species) interbreeding individuals" - Mather and Gregg. Population geneticists restrict the definition, further, to a population of genes rather than to that of individuals. The population of genes under consideration is termed a Gene Pool and represents the total collection of all the allelic forms that are carried by all the gametes of a population. It is the total genetic information possessed by a population. The basic unit of such a population has been termed variously as panmictic by Sewall Wright, Local Mendelian Population by Dobzhansky and Gamodeme by Gilmour and Gregor. The term that is mostly in vogue today for a genetic population is the Deme. A deme represents a local population of interbreeding, or potentially inbreeding, individuals in a given locality; that is, any gamete in this population has an equal chance to unite with any gamete of the opposite sex in the same population and result in a viable zygote. An ideal deme is, of course, a panmictic one.

Successful reproduction requires sexual behavior culminating in copulation, fertilization, normal development of the fetus, and offspring that are normal and healthy, capable of reproducing in turn. A number of conditions can prevent closely related populations from exchanging genes by preventing successful reproduction. One of the many ways this may occur is if the sexual behavior of the male, such as the mating dance of birds, fails to stimulate the female of a closely related population. Several forms of reproductive isolations are already discussed in the chapter on Modern Synthetic theory.

Of course, successful reproduction of a population requires a rate of reproduction sufficient to sustain the population. The number of individuals produced in each generation must be great enough to compensate for deaths due to accident, predation, disease, etc. However, the rate of reproduction cannot be so great that the population will increase to the point where it can no longer be supported by its food sources or other elements in the environment. In other words, a successful reproductive rate is one that maintains a balance between population size and the potentials and limitations of the environment.

The largest natural population is the species, the members of which are potentially capable of successful reproduction among themselves but not with members of other species. Species can be broken down into smaller reproductive populations, which are to some degree, and often temporarily, isolated from one another.

Phenotype in a Mendelian Population: Just as one can speak of the phenotype of an individual, it also is possible to speak of the phenotype of a whole population. Since a population is made up of varied individuals, such a description must be handled statistically. For example, the average stature of a population can be calculated and the variation from that average noted. It is also possible to calculate the percentage of blood type O, blue eyes, red hair, and so on, and emerge with a statistical profile.

Genotype in a Mendelian Population: It also is possible to speak of the collective genotype of a population. This is known as the gene pool. The frequencies of genes in a gene pool can be calculated by formulae which we shall discuss later. Each individual can be thought to contribute one cell to the gene pool. From these cells the genes can be extracted and tallied. It may be noted, for example, that if the alleles for PTC tasting in a population are tallied, 41.3 percent of them are dominant (T) and 58.7 percent are recessive (t). On further examination it might be found that 17.1 percent of the genotypes that emerge from the gene pool of PTC genes are homozygous dominant, whereas 48.4 percent are heterozygous and 35.4 percent are homozygous recessive. The frequency of these genotypes makes up a statistical statement about the genotypes of the population.

POPULATION GENETICS

The need to understand the behavior of genes in the gene pool rather than in individuals is important to several areas of theoretical and applied biology.

Take the case of the agricultural practice of breeding for improvement of cultivated or domesticated stocks of plants and animals.

1. It was observed that variety and vigor could be maintained only if there existed a certain degree of heterozygosity in the strains that are crossed. The question naturally arose: How does one ensure the optimum amount of heterozygosity or desirable traits in stocks of interest? To answer this, it is necessary to know how genotypes are maintained in populations, as well as the factors that affect their maintenance. Such knowledge is expected to lend to the development of more rational methods of stock improvement.
2. A second area that benefits from knowledge of genes in a population is human genetics. For obvious reasons, man is not amenable to genetic experimentation in the conventional manner. However, it has been possible to glean a great deal about the distribution and dynamics of human genes by combining analyses of pedigree charts and of distributions of genes in finite populations. The methods of population genetics have been particularly fruitful in the detection of rare inherited

- ① It describes a situation where there is no evolution, thus it provides a baseline for measuring evolutionary change.
- ② Helps in understanding of micro & macro evolution caused by migration, hybridization, isolation, mutation, G&E selection.
- ③ Can be applied to specific human traits to obtain statistical information about the allele & genotype frequencies. Ex: X-linked genes (Haemophilia).

- ④ Helps in understanding the effect of increased homozygosity in case of inbreeding/cousinage.
- ⑤ Helps in understanding how high frequency of certain harmful alleles in isolated groups is due to founder effect and (random) genetic drift.

Anthropology Paper 01 - Volume 01

✓ disorders and of infrequently occurring but hereditary behavioral aberrations. One of the obsessions of the biologists has been to understand how these deleterious alleles continue to exist in the population generation after generation.

3. Perhaps the greatest impact of population genetics has been in stimulating a search for realistic models that explain the process of evolution. Since evolution represents a shift in the genetic structure of a population, the most obvious way to understand evolution is to figure out how gene frequencies remain stable or change in response to environmental persuasions. This brings up the intriguing questions about how a strain manages to adapt itself to vastly different environments. Such adaptation is not the feat of an individual, but of an entire population. How is this achieved? Adaptation follows changes in several gene loci and is hardly expected to occur in a single individual. Imperceptible alterations in allele distribution in members of an inbreeding population can, however, become included in a large section of the population over a stretch of time. Once again, studying alterations in individual genotypes is not enough to provide an understanding of the dynamics of allele distribution in an evolving population.
4. A very useful spin-off of investigating the behavior of genes in populations has been the development of sophisticated mathematical methodologies which are of intrinsic interest even to mathematicians not concerned about their immediate practical applications. Mathematical models have been presented from time to time and refined as required to handle the complexities of dealing with several variables of alleles and environmental and other governing factor. These models try to depict the essence of the rules that govern genes in population, and even if they are not exact representatives of the actual situations, they are useful for furnishing scaffolding which can be utilized to design further experiments and test the parameters and tenets of hypotheses. Indeed, many of the simple deductions from the studies of population genetics have emerged from a mathematical approach to biological problems. In each instance, a statistical population of genes, rather than of specific individuals, is taken into consideration. The most significant model that provided the initial impetus to an intelligent study of genes in the population is the one known as the Hardy-Weinberg Model or Principle.

To understand how genes behave in a population, geneticists study the effects of factors that affect the genetic heritage of populations both spatially and temporally. The bewildering diversity of living forms is sufficient evidence that the genetic heritage of a population is not static. However, to study the dynamics of alleles in changing populations, a reference model would be convenient. Hardy and Weinberg provided such a standard against which deviations in population structure can be measured. The Hardy-Weinberg model represents a static genetic population, which is one in which genes undergo no change, so that its allele and genotype frequencies are in equilibrium, generation after generation. 2(b) 2(a)

Hardy, a mathematician, and Weinberg, an experimental biologist, independently arrived at the conclusion that, if certain disruptive factors are not in operation, the relative proportions of alleles of a gene locus remain in a constant proportion to each other in every succeeding generation. The Hardy-Weinberg law states that in a panmictic - randomly mating - population, without disruptive influences, the frequencies of alleles of a gene remain unchanged in every generation, but if this equilibrium is disturbed in some manner, the genotype frequencies reach a new equilibrium value in one or more generations, depending on the nature of the disrupting influence.

Although such an ideal population, or conditions, hardly exist, if at all, in natural environments, the Hardy-Weinberg law has served as a fundamental theorem in population genetics by supplying a norm or standard against which actual framework of gene frequencies can be measured.

In summary, population genetics deals with the dynamics of genes in potentially inbreeding communities. The frequency of genes and genotypes, and, therefore, the genetic structure of a population, remains stable from generation to generation, provided evolutionary agents do not disrupt them. Subtle changes occur, however, due to the disruptive forces that, in time, contribute to the segregation of a section of a

"Both the gene frequencies & the genotype frequencies will remain constant from generations to generations in an infinitely large population in which mating occurs at random and no selection, mutation or migration occurs"

Anthropology Paper 01 - Volume 01

gene pool into a population with an altered genetic structure. If the alteration is significant enough to prevent breeding with the parent population, the new set is considered to have acquired the status of a species. In short, an evolutionary change has taken place.

With this overview of population genetics and Mendelian population we proceed to brief descriptions of some of the fundamental concepts, methodologies and findings in this aspect of genetics which has generated tremendous interest in biologists and mathematicians.

GENETIC EQUILIBRIUM

A population is said to be evolving if the frequencies of its alleles are changing; it is not evolving if these frequencies remain constant. This latter situation is termed Genetic Equilibrium.

Certain conditions must be met with if the population is to remain in a genetic equilibrium.

1. **Random Mating:** Random mating denotes a union between gametes without reference to their genotypes. In random mating populations (panmictic), every gamete is assumed to have an equal opportunity of fusing with any other gamete of the opposite sex, resulting of course in viable and fertile offspring. In natural populations this condition may not be present. For, although any member of this population has the potentiality to breed with any other member of the opposite sex, the logistics may prevent such panmixis, with mating restricted within members confined to each other's vicinities. If such a population is further constrained in choosing partners, due to inbreeding, a significant alteration in gene frequencies will be noticed in comparison of those in the wider or bulk population. So, gene frequencies of non-panmictic and inbreeding populations will not be representative of those for the total gene pool of the species.
2. **Large Population Size:** Gene frequencies calculated from populations below a certain sample size may not be representative of the entire species. There will be significant sampling errors if the populations are not large enough. Moreover in the populations which are small, sudden random changes might have a significant evolutionary impact by drastically changing the gene frequencies.
3. **Lack of evolutionary forces:** Forces of evolution like mutation, migration, natural selection and random drift may alter the frequencies of the genes and alter the genetic structure of the population. How these alter the gene frequencies will be shortly discussed. However, Hardy-Weinberg Equilibrium assumes that no evolutionary forces are active in the population.
4. **Mating should be equally fertile:** The mating in the populations must produce the same number of viable offspring.

Deviation from the equilibrium shows that one or a combination of these conditions is not being met.

HARDY - WEINBERG EQUILIBRIUM

As already stated, mathematical calculations were independently made to understand whether a population is in genetic equilibrium, or not, for the first time in 1908 by Godfrey Hardy and Wilhelm Weinberg. Hence, genetic equilibrium is also termed Hardy - Weinberg equilibrium. The concept of Hardy-Weinberg Equilibrium can also be described algebraically. This results in the following general formula for the Hardy-Weinberg equilibrium.

$$p^2 + 2pq + q^2 = 1$$

Where $p = [A]$ and $q = [a]$, from which it follows that $[AA] = p^2$; $[Aa] = 2pq$; $[aa] = q^2$

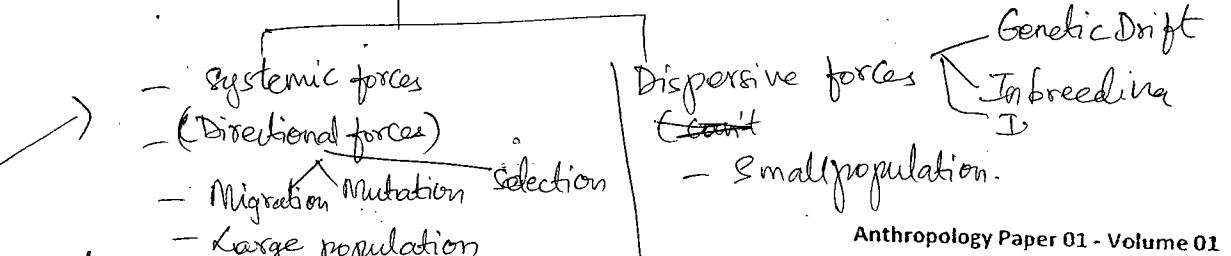
Here 'A' and 'a' are the allelic forms of one gene. Brackets are used to indicate "frequency of". The model of Hardy - Weinberg equilibrium presents a hypothetical situation of no change. It is a fact that

3) Significance of law ^{H.W.E} (a) Law is applied in population studies which have been recently extended for a detailed analysis of Dermal Ridge pattern on palms, fingers, thumbs, soles of feet
G.S. Kartic (karticsg@gmail.com)

(b) Gene freq. of Heterozygotes can be estimated.

(c) Multiple alleles

Useful to test population whether it is in H-W.E. by using chi-square test (χ^2)



populations do change that makes the model important. By being able to specify under what conditions a static condition would exist, we have already seen the requirements for it to exist.

In the above model, let us take the example of the pea plant experiment already discussed in the beginning of this chapter on Mendelian inheritance. In the first filial generation we have observed that the four possible genotypes in the offspring (after a cross between a genetically pure tall plant (TT) and a genetically pure dwarf plant (tt)) are TT Tt Tt tt

Here,

The frequency for the alleles TT i.e., $[TT] = \frac{1}{4}$

The frequency for the alleles Tt i.e., $[Tt] = \frac{2}{4}$

The frequency for the alleles tt i.e., $[tt] = \frac{1}{4}$

This pattern of allelic occurrence has already been discussed in the phenotypic ratio of 3:1.

However, in the context of Genetic Equilibrium, the same allelic occurrence can also be interpreted in a different manner using the Hardy-Weinberg equation, mentioned above.

Thus the allelic frequencies of TT, Tt and tt add up to 1. This is an ideal model for the genetic equilibrium.

However, no population is a perfect ideal type. There are certain forces which are responsible to bring about a change or disturbance in the Hardy - Weinberg equilibrium. These forces are discussed hereunder.

CAUSES AND CHANGES IN GENE FREQUENCY (page 18, 19 ref)

Natural populations are subjected to forces that prevent a population from maintaining an invariant genetic equilibrium. Most studied of such forces are mutation, migration, selection, random drift and inbreeding. We shall now consider each of these forces in turn.

1. MUTATION (page 18)

Variation is the basic ingredient for evolution. The larger the genetic variation available in a population, the greater the raw material at the disposal of selection agents. The primary source of genetic variation is, of course, gene mutation. Forward and reverse mutations are continuously adding new genetic material to a population. Variation can also be the outcome of genetic recombination events and of alterations in number and/or structural organization of genetic units larger than the unit of gene - such as chromosomes.

Recurrent mutation is a one way mutation by which mutation takes place from one allele to another in only one direction, i.e., A to a or a to A, and no reverse mutation occurs. Such persistent alterations of one allele into another would obviously erode the frequency of the original allele in the gene pool and increase that of the newly formed allele. However, under natural conditions, the rate of mutation in higher organism is extremely low and cannot possibly be responsible by itself in altering the frequencies of genes in a significant manner. Nevertheless, the rate at which this slow conversion of one allele into another takes place can be calculated and the value obtained is termed as the mutation pressure. For example, if the initial frequency of A is p_0 and "u" is the rate of mutation from A to a, in the first generation, the frequency of a becomes $u \times p_0$ and that of A is lessened and becomes $p_0 - u \times p_0$, i.e., $p_0(1-u)$ in one generation and for n generation, it will be $p_0(1-u)^n$. This is, usually, of a very low value - say in a 1000 generations, an allele A with frequency $p = 0.9$ may change to 0.899.

When both forward and reverse mutations occur, the effective proportion of alleles at any time will be given by the difference in rates of the mutation in the opposite directions. So, if mutation rate of A to a = u and mutation rate of a to A = v , in such a population, an equilibrium between frequencies of A and a will be reached when $u = v$, or the value of $p_0(1-u)$ remains constant over a period of generations.

2. SELECTION

- ✓ There is a natural discrimination against survival and / or mating success of certain allelic combinations in particular environments, so that only one or more specific combinations are favored. These combinations turn out to be the ones that allow the strain to adapt itself to specific niches. In other words, there is a subtle competition among genotypes, only some of which provide optimum traits for surviving successfully in preferred situations. In short, certain combinations of genes undergo a process of selection, the idiosyncrasies of the environmental niche acting as the selection pressure.
- ✓ Particular genes of the genetically fitter individuals will, therefore, increase in frequency. Such fitness for survival is what Darwin indicated as the main criterion for adaptive evolution. The traits that make the successful offspring well adapted are presumed to accumulate over generations and slowly but inevitably change the genetic structure of a population. The alteration may result in the delineation of a species or of a higher category - genus, family, and phylum.

Selection may thus be viewed as

(9)

1. A process that generates greater diversity in genotypes or

✓ 2. A means of reducing variability by elimination of genotypes Sub optimal in fitness for adaptation.

✓ Selection may be induced by a variety of physical, chemical and biological agents. Temperature, light intensities, availability of food in general or minerals in particular, presence or absence of predators and a host of other factors may act as selection pressures, persuading the direction in which selection will occur.

Measure of Selection Force

✓ Selection may be measured by its fitness for the environment. The fitness of a genotype is an expression of the ability to produce viable and fertile offspring - i.e., of its reproductive success. Another way of indicating the reproductive ability of a genotype is by assuming a value termed selective value or adaptive value.

The selective value of a genotype is the measure of offspring produced by it, relative to those of another. If, for instance, a genotype produces 100 viable and fertile offspring, and another only 70, the reproductive capacity of the latter is less than that of the former by 30 percent. In abstract terms, the ratio of offspring of a genotype that are viable and fertile as compared to those of other genotypes is designated by the letter "w". The most successful genotype can be assigned a value of 1 for "w", while the least successful, or lethal genotypes with $w = 0$. Other values range between 1 and 0. The discriminatory selective force which lessens the adaptive value of a genotype from the ideal is termed the selection coefficient, "s". In the above example, "w" for the most successful genotype has no selection coefficient working against it, so that $s = 0$, while for the less successful genotypes is 0.3. In other words $w = 1-s$ and $s = 1-w$.

Usually, the most favored genotype is assigned the value of 1 and others are assessed relative to this norm.

✓ Selection occurs on whole genotypes of individuals and not against individual alleles. However, if several individuals have certain combinations of alleles in common, one may speak of selection for or against some of these allelic combinations. An allele for instance may be selected for in a particular setting of genes, while it may be selected against in another. The selective value, therefore, depends really on the interrelationships in the expression of all the genes in a genotype and not specifically on one or more alleles.

3. MIGRATION AND ISOLATION 9

(+) Hybridization (+) Gene flow

Mutation, by itself, is not a very effective force in changing frequencies of alleles in a population, primarily due to its very slow rate. A much faster way of altering gene frequencies is provided by migration. A group of individuals from another population, which can interbreed with the recipient population, and which has an allelic frequency pattern distinct from that of the population with which it is merging, will quickly affect the original allelic frequencies in the recipient group. The difference in the recipient and migrant allele frequencies is a consequence of adaptation to particular environmental niches over long periods of time. To become optimally adapted to a locale, certain alleles are favored and retained in larger proportions than others which are selected against. As conditions in different environs require different traits for optimum efficiency of living and reproducing, such isolated populations develop characteristic differences in the allelic frequencies of the same gene.

Let us consider a group of migrants entering an isolated population. The following figures are to be considered. We will consider the frequency of an allele say "a".

Total number of Recipient population = M

Total number of migrant population = m

Frequency of the allele a in the recipient population = q_a

Frequency of the allele a in the migrant population = q_b

Hence, the

Total number of alleles a in the recipient population = Mq_a

Total number of alleles a in the migrant population = mq_b

Hence, the

Total frequency of the allele a in the mixed population $Q = q_a + q_b$?

Total number of the alleles a in the mixed population = $Mq_a + mq_b$

Thus the change in the frequency of the allele after migration can be denoted by $Q^a = q_b - q_a$

If the frequency of allele a in the migrants is higher than that in the recipient, the value of Q^a will have a positive value and in the converse case, a negative one. The differences between the two frequencies are a measure of migration and are called as the migration coefficient.

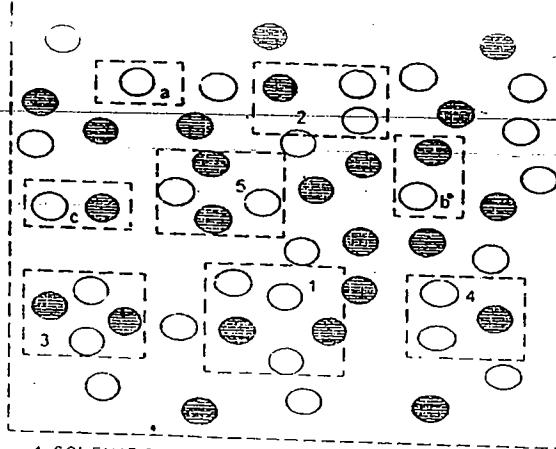
Migration is often referred to in terms of migration-pressure of gene flow and is a measure of the migration coefficient and difference in gene frequencies. Migrations between isolated populations of the same species bring about a greater variation within that species.

Define 9

4. GENETIC DRIFT (P.Nath) (Page 19)

Any population, no matter how large, is a finite one (of N individuals), and may not necessarily reflect the pattern of allele distribution in the more global gene pool.

In the figure given the large square represents the total gene pool, and the smaller squares (1, 2, 3, 4, and 5) represent various portions of this larger pool. One will notice that not all the squares give a correct picture of the ratio of black and white circles for the entire pool. It is also evident that the smaller the chunk chosen,



A SCHEMATIC REPRESENTATION OF RANDOM DRIFT

LARGER SAMPLES: 1, 2, 3, ...

SMALLER SAMPLES can bring change in gene freqs.

136

The random factor in evolution, which is primarily due to sampling phenomenon, is called Genetic Drift.

G.S. Kartic (karticsg@gmail.com)

Evolutionary change due to ~~random~~ in populations related to population size i.e., smaller the population

to the size of pop as well. $\text{GD} \propto \frac{1}{\text{effective pop size}}$

But it fails if sample size is $> 10\%$ of pop size - coz it is a random statistical effect & not biological process.

- Also called Sewall Wright effect

- More effective in very small pops, large pops - not effective

(4) - Also more effective in Isolated pops.

(1) Ex:- 100 people - 95- δ group blood - 5- β group -

Effects of GD

- ① Bottleneck effect
- ② Founder effect

Anthropology Paper 01 - Volume 01

the greater is the chance of it being an atypical segment.

Such a typical set of a gene pool may lead to an altered genetic structure of the population. The extent of deviation is seen to occur within certain predictable limits. The results are not very much unlike those in inbred populations especially in the tendency of one or more alleles to become fixed, or become homozygous in most members of the population. Such fixation or homoallelism is more likely to occur in smaller population.

Causes of GD: Inbreeding, Migration, Natural calamities, Some people not being productive

Sewall Wright's Studies: Ex:- ① Six-fingered Dwarfism in old order Amish (Pennsylvania) → Inbreeding

(6) (i) Sewall Wright was the first to investigate the extent and effect of random genetic drift. For this reason the drift is often referred to as the "Sewall Wright Effect".

(ii) Sewall Wright developed mathematical models for assessing deviations in gene frequencies in generations. According to this model, the deviation from mean frequencies of alleles can be represented by the equation

$$\Sigma = pq/N$$

Where Σ (Sigma) represents standard deviation, p and q are frequencies of alleles A and B, and N is the size of the population.

5. INBREEDING + pg (140)

One of the chief conditions for realizing the Hardy-Weinberg equilibrium is that the population under consideration breeds randomly. In actual circumstances, though, ideal random mating is a rarity. The reasons for this are not difficult to imagine. Although, there may be a large settlement of individuals of the same interbreeding species in a locality, the mating between individuals are usually dictated by proximity, choice and other factors, and are restricted, to a small group of individuals in the immediate neighborhood. So, although, theoretically the entire population is at the disposal of an individual, it rarely uses this wide opportunity. As a result, two extreme types of mating happen to be quite common. These are inbreeding or mating between closely related individuals, and out crossing - or mating between very much unrelated individuals. Closest type of I in Bisexual organisms - Self-fertilisation; In Unisexual - Back cross

Both forms of mating have been used in selections, for the specific purpose of producing desirable varieties of plants and animals. When close relatives are bred together, homozygosity is attained very easily in several loci. If this breeding is continued systematically for several generations, the progeny will separate out into separate stocks, each homozygous for specific alleles. These are the true-breeding stocks of breeders. A defect of this procedure is that together with the desirable alleles, many other non-desirable (deleterious to the organism) alleles also become homozygous. The total effect of such homozygosity is a weaker, or less successful, or less fit member of the species. Inbreeding, thus, lowers the fitness or adaptive value of species. It suddenly called upon to cope with a new set of circumstances, such an inbred stock would be unable to do so since many of the genes that could have helped in this new situation have been lost.

One method in nature, therefore, of maintaining sufficient genetic variability in a population is to ensure crossbreeding. Many mechanisms have been evolved which promote cross pollination or cross fertilization. The offspring of cross bred individuals have been found empirically to be stronger or better products than those of inbred lines. This fact was exploited by breeder-geneticists in producing unusually vigorous progeny from widely different parents. This excess superiority or vigor, or increase in degrees of expression of several traits, has been named heterosis, or hybrid vigor, and has been exploited commercially.

With every succeeding generation of self fertilisation, the freq of Heterozygote drops by 50%.
By 10th Generation, the pop would be 99.9% homozygotes.

Study in UK → 3% of children born out of blood related unions suffer from congenital problems
(1.6% of non-blood "

Problems include heart, nervous disorders, limb anomalies etc.

- Gotra system in South India is formulated → ~~to prevent~~ warns people against marrying within same gotra (clan) Ex - Haryana honour killings
- More required
- Egyptian Pharaohs practiced brother-sister marriages. Similarly in Parsi community, Ashkenazim Jews of Russia.

Anthropology Paper 01 - Volume 01

CONSANGUINEOUS AND NON-CONSANGUINEOUS MATING

- This is to prevent outflow of wealth. The simplest type of mating is called as Random Mating. In this type of mating, an individual of one sex has an equal probability of mating with any individual of the opposite sex in the population. This type of mating is also called as Panmixis.

~~First cousin~~ ✓ However, random mating is prevented by certain factors. Such factors, to name some are the mate preferences and social factors. Random mating forms the foundation of population genetics as was discussed by Hardy Weinberg Law. A deviation from random mating is Inbreeding.

~~Second cousin~~ ✓ Inbreeding is a departure from random mating and it is the mating between genetically related individuals. It is a situation of Genetic Consanguinity. It was discovered by the geneticists that close inbreeding is detrimental to the offspring and cross breeding is, on the other hand, beneficial. Perhaps for the same reason, the laws and customs of the people still forbid marriage of certain near relatives.

The closest type of inbreeding in the bisexual organisms or the hermaphrodites is Self fertilization. In the unisexual organisms, the closest type of inbreeding is Back Cross. This is the crossing to a single homozygous parental type. (Refer the topic on Mendel's laws). Self fertilization tends to make a population pure breeding according to the Mendel's laws of genetics. In inbreeding, in the gene pool of the population, the frequency of heterozygotes decrease in size and that of homozygotes increase. Inbreeding, thus, does not give opportunity to the formation of heterozygotes. This is because there is no chance of new genes or alleles entering the gene pool.

The chief advantage of cross fertilization over inbreeding is the greater opportunity for appearance of new and better combination of genes. Continuous inbreeding in the absence of cross fertilization will result in accumulation of injurious recessive genes because these rare recessive genes so far were concealed by normal dominant genes. The effect of inbreeding is more likely to be injurious than beneficial.

~~Hybridisation~~ ✓ ~~or~~ ✓ Gene flow ✓ is a basic evolutionary mechanism which brings about a change in gene frequencies of a pop by disturbing the Hardy Weinberg equilibrium. Hybridization or Gene flow is a means by which genes already present in some population are introduced into the other. It may result in genetic combinations which are entirely new. When we say that new genes are introduced in a population, it also means that genetic variations are introduced in it. This process is also called as Migration or Admixture. ✓ It shows

Hybridization results when individuals from outside contribute their genes to the pool of a population and alter their gene frequency as a consequent. There may be a series of migrations between adjacent populations resulting in appearance of genes from a point of high frequency to that of a point of low frequency. A person may pass the gene to some one who will in turn repeat the process. This results in the spread of genes to vast distances while carriers themselves may remain relatively stable.

Such a kind of a Gene flow where a gene is spreading from a local population results in a gradually decreasing frequency along the line. This line indicates the direction and magnitude of Gene flow. This frequency gradient is called as a Cline. An example of this gradient is the epicanthic fold which flows from Himalayas to Orissa.

Usually well separated populations are connected by numerous intermediate groups through which genes can flow and give rise to a geographic gradient of gene frequency between two polar populations. Such gradients in gene frequency are known as Geno Cline and a gradient of trait is called as a Pheno Cline.

The migration of population into new territories may lead to contacts accompanied by gene exchanges between diverse populations formerly separated by great distances.

The formation of new gene pools by interbreeding two populations is a slow process. Populations may live side by side for hundreds of years and yet may retain genetic diversity. This can be possible only by the cultural factors like endogamy. Such factors restrict gene diffusions in one direction.

It shows the process of population differentiation & can be referred to as a stabilising mechanism.

- ② C marriages will be deleterious, if homozygosity for genes is deleterious.
- ③ May cause decline in freq. of ~~that~~ few genes.
- ④ A detrimental gene may have effects on some complex attribute like skeletal dev (or) mental traits.
- ⑤ Also, defects may arise from interaction btw given genotype & envts.
- ⑥ ↑ of defective children is due to contribution of rare recessive genes.
- ⑦ In few cases, homozygosity at single locus may ~~cause~~ be main cause of defect; in other cases, simultaneous homozygosity at several loci.
- ⑧ One advantage - when mother & child are genetically similar, then no unfavourable result occurs.

Hybridization may also mean admixture of two or more genetically dissimilar population to form hybrids.

Two new populations when come in contact, it is very rare they form a new panmictic unit immediately.

This feature is particularly slow if the populations differ greatly in their physical features and social customs. ^{Anthropology Paper 01 - Volume 01} (9) studies show rate of mortality among children of 1st cousin marriages is higher.

(10) Infants of 1st cousin marriages are shorter & lighter.

✓ Hybridization or Gene flow is a basic evolutionary mechanism which brings about a change in the gene frequencies of a population by disturbing the Hardy Weinberg Equilibrium. It breaks the isolation and makes the gene frequencies remain similar. Isolation, resulting from the absence of Gene flow may permit genetic drift to cause a divergence. Gene flow slows the process of population differentiation as the genetic drift speeds it up. Gene flow hence can also be referred to as a stabilizing mechanism.

GENETIC LOAD

- 1 Genetic Polymorphism is not necessarily an unqualified boon to a natural population. The vast genetic diversity that is present obviously includes several alleles which do not impart optimum fitness to the population, and may, in fact, be quite harmful for its existence. Such deleterious genes are a sort of genetic liability to the population. This liability tends to decrease the potential optimum fitness of a population and is known as the genetic load of the population. Crow defines genetic load as the "proportion by which fitness of the average genotype in the population is reduced in comparison with the best genotype". (Deviation of observed fitness from that produced by optimum Genotype)
- 2 Types of Genetic Load (MLS)
- 3 Three major types of genetic loads originate and are maintained in a population.

1. **Mutational Load:** It is the slicing away of the genetic variability of a species due to the occurrence of recurrent mutations. Deleterious genes are eliminated in an optimally fit population but beneficial or advantageous genes may also be eliminated, thus leading to genetic burden.

2. **Segregational Load:** It is represented in those situations where the heterozygotes are more successful in efficient living than the homozygotes. The inferior homozygotes which are continuously being segregated in each generation represent the liability the population carries without any immediate and obvious utility value. Segregational load can cause greater lowering of genetic variability than mutational load.

3. **Incompatibility Load:** It is encountered when certain genotypes are unable to survive in the environment of specific parental genotypes. The conception of an Rh positive child to an Rh negative mother is a common example of this type of genetic load. In this situation Rh hemolytic disease of the new born or Erythroblastosis foetalis is caused by Rh factor incompatibility between a pregnant woman and her fetus. It can occur only when the mother is Rh negative and the father is Rh positive. Because the Rh factor is genetically dominant, the resulting fetus may be Rh positive. The disease develops if fetal Rh factor enters the mother's circulatory system through a breach in the placenta, usually late in the pregnancy or during delivery. The mother's immune system treats the fetal Rh factor as a foreign protein and produces antibodies against it. The antibodies can pass through an intact placenta into the fetal circulation and cause a potentially fatal anemia by destroying the RBC.

Intro :- Genetic Load (i) given by H.J. Mueller based on effects of Nagasaki & Hiroshima (ii) is a measure of no. of disadvantageous genes in a pop (or) of damage done to pop by certain genetic factors

- 6 Effects → (1) Endinction of species (2) Significant ↑ in incidence of disease may occur in inbreeding pops due to dev of homozygosity (3) Sex ratio may alter in long run.

An approach to the study of relationship btw inbreeding & its presumed Genetic effect lies in the estimation of 'genetic load'.

Inbreeding coefficient is the correlation between uniting gametes (by Sewall Wright) $F = \frac{1}{2^n}$

- Consanguineous mating will increase Genetic Load

More required

Look back for extra info Current Affairs

Anthropology Paper 01 - Volume 01

P. Nath
PG 120

GENETIC EFFECTS OF CONSANGUINEOUS AND COUSIN MARRIAGES

NON RANDOM MATING

Genetic recombination does not by itself alter allele frequencies. However, any consistent bias in mating patterns can alter the genotypic proportions. By affecting the combination frequencies of genotypes, nonrandom mating causes deviations from the Hardy Weinberg expectations. It therefore sets the stage for the action of natural selection.

✓ Basically, there are three models of nonrandom mating - positive assortative mating, negative assortative mating and inbreeding.

A Positive Assortative Mating: This occurs when individuals of like phenotype mate more often than expected by random mating predictions. Because individuals with like phenotypes are also similar to some degree in genotypes as well, the result of positive assortative mating increases the amount of homozygosity in the population and reduces heterozygosity (P^2 and Q^2 greater than expected; $2pq$ less than expected). Ex. Stature and IQ or Eye color.

B Negative Assortative Mating: This involves mating with an individual who is phenotypically dissimilar. Theoretically, if this occurs more than expected by random mating predictions, it should increase the amount of heterozygosity in the population while correspondingly reducing homozygosity.

C INBREEDING + pg (137) - I is reproduction from mating of parents who are closely related genetically

Inbreeding, also called consanguinity, occurs when relatives mate more often than expected. Such mating will increase the amount of homozygosity, since relatives who share close ancestors will more than likely also share similar genes. Inbreeding occurs less frequently than predicted under random mating because all societies have some form of incest taboo, especially nuclear family. Inbreeding reduces the variability among the offspring thereby reducing the reproductive fitness. In some societies, due to the small number of potential mates available, inbreeding among fairly close relatives such as cousins is actively encouraged or is unavoidable. Ex. Pitcairn Island and Tahitian wives. There are some areas, on the other hand, where inbreeding is avoidable but it is still actively encouraged. In some parts of Japan among certain social classes, first cousin marriages make up almost 10% of all marriages, and in Andhra Pradesh of India, among certain castes, uncle/niece marriages also make up about 10% of marriages.

However, such considerable inbreeding is an exception rather than a rule among human populations and most groups actively work very hard at maintaining exogamy. As a general rule, then, most human populations do not inbreed if they can at all help it. Inbreeding has important medical consequences in addition to its effect on genetic equilibrium. When relatives mate, their offspring have increased probability of inheriting an allele in homozygous dose.

Any departure from random mating naturally leads to complications in the relationships between allele frequencies and genotype frequencies. If a heterozygote Aa is self fertilized, it will produce three kinds of progeny AA , Aa and aa , in the ratio of 1:2:1. At this stage, the frequency of the heterozygote is 0.5. If self-fertilization is continued for another generation, the homozygotes will breed true but the heterozygotes will again segregate, reducing their frequency to 0.25. With every succeeding generation of self-fertilization, the frequency of the heterozygotes drops off by 50%, reaching 0.008 by generation seven and 0.001 by generation ten. At this stage, the population is 99.9% homozygous.

The process of repeated self-fertilization illustrates the general effects of a form of nonrandom mating called Inbreeding. Inbreeding occurs when the mates are genetically related. Self-fertilization is the extreme example, but other examples such as the mating of full siblings, first cousins, parents and offspring, and half siblings have the same effect, namely, to increase the frequency of homozygotes and decrease the frequency of heterozygotes. As a result, the Hardy Weinberg method does not hold.

- Inbreeding results in increased homozygosity, which can increase chance of offspring being affected by recessive (or) deleterious traits.

G.S. Kartic (karticsg@gmail.com)

140

- This generally leads to decreased fitness of a pop, which is called inbreeding depression.

X Target Material

9.4 CHROMOSOMES AND CHROMOSOMAL ABERRATIONS IN MAN

Diagnosis

Preparing chromosomes for analysis is relatively simple. Circulating blood lymphocytes are generally used, except in the fetus, in whom amniocytes from amniotic fluid or chorionic villus cells from the placenta are used instead. The cells are cultured in the laboratory with phytchemagglutinin to stimulate cell division. Colchicine is then added to arrest mitosis during metaphase, when each chromosome has replicated into two chromatids attached at the centromere. The cells, which are spread onto microscope slides, are then stained. Chromosomes from single cells are usually photographed, their images cut out of the print and pasted onto a piece of paper, forming a karyotype. Computer imaging can also be used to produce a visual display of the chromosomes.

Chromosome staining is performed by G (Giemsa) or Q (fluorescent) banding techniques. Additional staining procedures and techniques for extending chromosome length have greatly increased the precision of cytogenetic diagnosis.

New molecular techniques use DNA probes (which can have fluorescent tags) to locate specific genes or DNA sequences on the chromosomes. Fluorescent In Situ Hybridization (FISH) is used to identify the organization of genes and to look for deletions, rearrangements, and duplications of the chromosomes.

Karyotype nomenclature is as follows. The normal male is designated as 46,XY and the normal female as 46,XX. In Down syndrome due to an extra chromosome 21 (trisomy 21), the notation is 47,XY,21+ for a male and 47,XX,21+ for a female. In Down syndrome due to a translocation (two chromosomes that are stuck together), the typical 14/21 "balanced translocation carrier" mother is written as 45,XX, t(14q;21q). The translocation chromosome (t) is formed from 14q and 21q (in which q is the long arm); the short arms (p) are lost. For a deletion of the short arm of chromosome 5 (as in the 5p deletion syndrome), the female karyotype is 46,XX,5p-.

Each arm of a chromosome is divided into one to four major regions, depending on chromosomal length; each band, positively or negatively stained, is given a number, which raises as the distance from the centromere increases. For example, 1q23 designates the chromosome (1), the long arm (q), the second region distal to the centromere (2), and the third band (3) in that region.

Chromosomal aberrations have been classified into two types depending upon the type of changes they bring about i.e., changes in the chromosomal structure and in the chromosomal number. Apart from this, you are expected to also know the various types of chromosomes in the human body, the insight into which will provide a better understanding of the various chromosomal disorders in man.

In all the sexually reproducing organisms, chromosomes exist in homologous pairs. In the humans, the organism of our interest, there are 23 pairs of chromosomes (total 46 in number). Not all these chromosomes are similar in their structure and function. They differ in their structures and vary in their functional attributes. These functional aspects of a chromosome depend upon the genes each chromosome carries. All the genes present on the same chromosome are said to be "linked" and form a linkage group.

In many sexually reproducing organisms, including the humans, one pair of chromosomes found in the male of the species does not fit the description of homologous chromosomes. The members of this unique pair neither look alike nor seem to carry genes that are allelic. But they are of vital importance because the very existence of the species depends on their presence, for they determine the sex of the individual, they are the sex chromosomes and the others are termed as autosomes.

Refer
McGraw Hill for
linked/
non-linked

The tiny chromosome that determines the maleness in the human beings is the Y chromosome. When the Y is absent, the individual is female.

- ⑥ Major cause of spontaneous human abortions & abnormalities in live births
⑦ Significantly alter the frequently found in ageing tissues ~~in tumour cells~~ & might contribute to tumorogenesis.

Intro: NA involve the loss/gain of a whole chromosome (or) chromosomes & can include aneuploidies (or) sex chromosomal. Generally loss would have greater effect than gain.

Anthropology Paper 01 - Volume 01

The X and Y chromosomes segregate as a homologous pair during gametogenesis. Following spermatogenesis, half the mature sperms therefore contain Y chromosomes, and half carry the X chromosome. Since the mature ovum, or egg cell, can have only the X chromosome, the sperm which fertilizes an egg will determine the sex of the child conceived. The Y bearing sperm determines that the child is a boy and the X bearing sperm determines that the child is a girl. This means that the father is the parent whose germ cells determine the sex of the children.

With this background, we shall proceed with the discussion on the various types of chromosomal disorders in human being.

NUMERICAL AND STRUCTURAL ABERRATIONS

Numerical 3 Numerical aberrations of chromosomes may involve the entire set, a condition called euploidy, or individual chromosomes, called aneuploidy. Aberrations involving individual chromosomes i.e., aneuploidy, are indicated by the suffix -osity. Thus, the presence of an extra chromosome 21 is called trisomy 21. An individual possessing only one rather than a pair of 21 chromosomes would be monosomic 21. ~~Loss of a chromosome would have greater effect than gain of a chromosome.~~

Although polyplody (extra set of chromosomes) is known to be a viable condition in other organisms, such as some plants, it seems to be fatal to the humans. There are however a number of conditions found in humans resulting from aneuploidy of both autosomes and sex chromosomes.

- Structural 1 Structural changes require breaks in the chromosomes. More than one break can occur in a single chromosome or set of chromosomes, and the broken parts may then reunite in new arrangements. Any broken end may unite with any other broken end, thus potentially resulting in new linkage arrangements.
2 The loss or addition of a chromosome segment may also occur in the process. More than one type of aberration may occur at the same time. For example, a section may be broken off and lost during the formation of an inversion or translocation; thus simultaneously producing a deficiency.

SEX CHROMOSOMAL ABERRATIONS

KLINEFELTER'S SYNDROME (47,XXY)

Non disjunction produces gametes with extra sex chromosomes; one would also expect trisomy of the sex chromosomes if the gametes containing an extra sex chromosome took part in fertilization. Conditions resulting from trisomy of the sex chromosome in fact occur even more frequently than the Turner's syndrome.

- 4 If a sperm from nondisjunction were to fertilize a normal X bearing ovum and if XX ovum rising from nondisjunction in oogenesis were to be fertilized by a normal Y bearing sperm, the zygotes in each case would be XXY.

2 This imbalance in the number of sex chromosomes leads to a series of abnormalities known collectively as Kleinfelter's Syndrome.

- 2 An extra X-chromosome in addition to the usual male XY chromosome complement (47,XXY) has been associated with the abnormal male syndrome described by H.F. Kleinfelter. It is estimated to occur in 1 per 500 live births. Individuals with this syndrome are phenotypically males but with some tendency toward femaleness, particularly in secondary sex characteristics. Such features as enlarged breasts, underdeveloped body hair, small testes, and small prostate glands are a part of the syndrome. Presumably, the XXY constitution originates either by fertilization of an exceptional XX egg by a Y sperm or of an X egg by an exceptional XY sperm. Studies of Kleinfelter's syndrome and Turner's syndrome indicate that the Y chromosome in human beings determines male sex.

- 5 The most common karyotype for Kleinfelter's syndrome is 47,XXY, but the symptoms of the syndrome will usually occur whenever more than one X chromosome is present along with a Y chromosome. More

Anthropology Paper 01 - Volume 01

complex karyotypes associated with the Kleinfelter's syndrome include XXYY, XXXY, XXXXY, XXXXX, XXXXYY and XXXXXY. Mental retardation is usually found when there are more than two X chromosomes. Thus this syndrome brings about both physical and reproductive anomalies.

TURNER'S SYNDROME (45, X0)

This monosomic condition has a chromosome number of 44 autosomes and one X chromosome. The chromosome anomaly is associated with an abnormal female phenotype described in 1938 by H.H. Turner and associates and known as Turner's syndrome. It occurs in about 1 in 2500 live females' births. More than 90 percent abort spontaneously. These adults have virtually no ovaries, have limited secondary sexual characteristics, and are sterile. Microscopic sections of the ovaries show fibrous streaks of tissue representing remnants of ovaries. Affected females have short stature, low set ears, webbed neck, and a shield like chest. Mental deficiency is not usually associated with this syndrome. Since there is a loss of one sex chromosome (X) thus resulting in one less chromosome in the karyotype i.e., 45 instead of 46. Turner syndrome can also be represented as (45, X), whereas the normal is (46, XX).

These patients i.e., the X monosomics probably originate from exceptional eggs or sperm with no sex chromosome or from the loss of a sex chromosome in mitosis during early cleavage stages, after an XX or XY zygote has been formed. Most of the cases of somatic Turner's phenotype have normal X chromosome and a fragment of a second X chromosome. Both arms of the second X chromosome are apparently necessary for normal ovarian development and differentiation. Individuals with only the long arm of the second X chromosome are short in stature and show other somatic symptoms of Turner's syndrome, whereas those with only the short arm of the second X have normal stature and do not show as many signs of Turner syndrome. This indicates that the Turner's phenotype is mostly controlled by genes on the short arm of the X chromosome.

A Y chromosome also occurs in some individuals with one X and a fragment of Y, not including the short arm of the Y chromosome. These individuals have streak ovaries but are normal in phenotype. This suggests that male determining genes are in the short arm of the Y chromosome, and those that prevent the Turner's phenotype are in the Y long arm as well as the X short arm. Major features of the Turner's syndrome are characterized by defective development of the testes, sterility, and limited male secondary sexual characteristics, along with somatic features of the Turner's phenotype.

The Turner's syndrome individuals result from nondisjunction of the sex chromosomes, both male and female. In both the cases, if the Nullisomic gametes (O) were involved in fertilization with an X bearing gamete from the other parent, the resulting zygote would be X0.

Conclusion

XXX SUPER FEMALES

(?) meta females

Fertilization of XX germ cells by X bearing gametes results in XXX persons, or "super females". There is no characteristic phenotype associated with this aneuploid condition. The level of intelligence and development of the reproductive system vary from normal to subnormal.

XY SYNDROMES.

Another type of abnormal sperm is created by the nondisjunction of Y chromatids. The result is a spermatid without sex chromosomes and a spermatid with two Y chromosomes. Fertilization involving either of the two abnormal sperms results in an imbalance of sex chromosomes in the zygote. The O sperm leads to Turner's syndrome when it fertilizes a normal X bearing egg. The YY sperm results in an interesting condition, XYY, which has been referred in the past as the Criminal syndrome, since at one time it was thought that persons possessing the XYY complement tended to commit acts of violence. The association of the XYY chromosome complement with aggressive behavior stems from some studies in the mid 1960s of patients in mental institutions and prisons. These studies indicated that a relatively large percentage of inmates were XYY.

3. Unusually long legs, slender torsos but otherwise appear normal.
4. Normal development of sexual characteristics & are fertile.
5. Slight learning difficulties & are in the lower range of normal intelligence.
6. Emotionally immature for their age during childhood.
7. None of these traits prevent them from being socially accepted as ordinary adult women.
8. Freq. - 1/10

Anthropology Paper 01 - Volume 01

Persons with sex chromosome abnormalities should not be confused with transsexuals, those who undergo surgery for a change in sexual phenotype. The latter are usually genetically and phenotypically normal but have deep rooted psychological problems accepting their given sex. Still other individuals are true intersexes in the sense that they possess both ovaries and testes. They are called hermaphrodites.

INTERSEX STATES

Conditions in which the appearance of the external genitalia is either ambiguous or at variance with the person's chromosomal or gonadal sex.

1 The genitalia form during the first 3 months of gestation via a cascade of events initiated by the fetal karyotype and mediated largely by the sex steroids. Aberrations in this cascade can produce genital ambiguities or inconsistencies, resulting in intersex states. Classification is most conveniently based on gonadal histology.

2 Female pseudohermaphrodites have ovaries and normal female internal genitalia but ambiguous external genitalia; they are genetically normal females with a 46,XX karyotype. The ambiguous external genitalia result from exposure to excessive amounts of androgens in utero. The offending androgen may be exogenous (e.g., progesterone given to the mother to prevent miscarriage) but is more commonly endogenous, e.g., resulting from an enzymatic block in steroidogenesis due to genetic aberrations on chromosome 5 (adrenal virilism or adrenogenital syndrome)

3 Male pseudohermaphrodites have gonadal tissue that is only testicular and usually have a 46,XY karyotype. The external genitalia are usually ambiguous, but this is variable and a female phenotype is seen in the complete form of the testicular feminization syndrome (androgen insensitivity syndrome). Etiology is complex, but in general terms the disorder arises from inadequate production of androgen or inadequate response to androgen

4 True hermaphrodites have both ovarian and testicular tissue, and mixed masculine and feminine genital structures depending on whether ovarian or testicular tissue predominates. In the USA, most true hermaphrodites have a 46,XX karyotype, but the pattern can be quite variable. Rarely, in true hermaphrodites the external genitalia is fully masculinized.

5 Patients with mixed gonadal dysgenesis have both testicular tissue and primitive gonadal tissue called streaks. These patients usually have a 46,XY/45,XO mosaic karyotype and ambiguous genitalia, and as adults they tend to be short of stature. When the streaks are bilateral, the disorder is termed pure gonadal dysgenesis. Such patients appear phenotypically as females.

6 Assignment of appropriate sex is paramount. Generally, female pseudohermaphrodites are assigned as females. Male pseudohermaphrodites are assigned according to their genital development and hormonal activity. True hermaphrodites are also best assigned according to their genital development, but most have been reconstructed as males - an attractive option if the child has a normally descended testis to provide hormonal function at puberty. Male pseudohermaphrodites with full-blown testicular feminization syndrome must be assigned as females, but for many others, male assignment is appropriate.

7 The rights of these minorities needs to be recognised & protected. Only very few nations recognise them as citizens.

AUTOSOMAL ABERRATIONS

DOWN'S SYNDROME first chromosomal disorder to be described in humans

1 It is one of the most familiar conditions in humans. Down's syndrome results from aneuploidy - trisomy 21. Hence the person with Down's syndrome has 47 instead of 46 chromosomes because of the presence of one extra chromosome number 21. This is the reason why Down's syndrome can also be represented as (47, +21). Originally studied by Langdon Down in 1866, it had been termed Mongoloid Idiocy or Mongolism because individuals with trisomy 21 were considered to have certain facial characteristics

- ① Occurs in all generations
- ② Equal no. of male female affected

Anthropology Paper 01 - Volume 01

that resembled oriental features. The condition is now referred to as Down's syndrome which removes the nuances of associating mental retardation with any particular race of people.

The presence of an extra copy of one of the smallest chromosomes in trisomy 21 results in a wide variety of abnormalities in almost every area of the body, differing in combinations and degree of severity from patient to patient. One of the most constant characteristics which allows doctors to identify Down's syndrome in very young children, even in new born babies, is the line found on the palms of both hands, which are known as dermatoglyphic patterns. The presence of a "simian crease" and a tendency for every finger to have a loop in the print region, rather than whorls or arches, distinguish the Down's child from a normal child. Because of various defects, such as in the cardiovascular system, the life expectancy of an individual with Down's syndrome is shorter than normal. One study sets the life expectancy at 16 years.

Other phenotypic characteristics of this condition are short stature (about 4 feet tall) and an epicanthic fold (thus the earlier name "mongolism"), broad short skulls, wide nostrils, large tongues with distinctive furrowing, stubby hands (particularly the fifth digit) and a general loose jointedness, particularly in the ankles. The patients are characterized as low in mental ability, but they can be trained in routine mechanical skills. Through the investigation of J. Lejeune in 1959, Down's syndrome became the first chromosomal disorder to be described in humans.

The incidence of Down's syndrome increases dramatically with maternal age. This increase is thought to result from the age of the egg cell that is fertilized to produce the zygote. The human female is born with an estimated 400,000 gametes and will not produce any new ones in her lifetime. Therefore, if a woman is 45 years old, her gametes are also 45 years old. Increasing age is believed to result in a tendency for a particular aberration of meiosis called Nondisjunction to occur. There has been little correlation found between the incidence of Down's syndrome and paternal age.

Nondisjunction: Nondisjunction can occur before either the first or the second meiotic division. The basic event in Nondisjunction is just what the term implies: The chromosomes do not separate i.e., they do not "disjoin". This results in aneuploidy in the daughter cells.

Gamete containing the extra chromosome will produce an individual with Down syndrome. Nullisomic gametes (gametes that are missing a particular chromosome altogether) are presumably nonfunctional or lethal. If nondisjunction occurs in germ cells that are normal, it is called Primary nondisjunction. If however, a trisomic individual reproduces the nondisjunction resulting in aneuploidy in the germ cells is called Secondary nondisjunction.

Down syndrome occurs once in about 700 live births in Europe alone. About one in six of the Down's syndrome children born alive die within the first year. The average expectation of life is 16.2 years. The cost of training and maintaining Down's syndrome cases in the United States is estimated at \$1 billion per year. Emotional stress in families with Down's syndrome children and adults is also a factor in their care. The need for effective counseling and prevention is readily apparent.

Amniocentesis for detecting Aneuploidy

Chromosomal abnormalities are sufficiently well understood to permit genetic counseling. A fetus may be checked in early stages of development by karyotyping the cultured cells obtained by a process called amniocentesis. A sample of fluid is withdrawn with a needle from the amniotic sac. Fetal cells are cultured and, after a period of two to three weeks, chromosomes in dividing cells can be stained and observed. If three number 21 chromosomes are present, Down's syndrome is confirmed. The risk for mothers less than 25 years of age to have the trisomy is about 1 in 1500 births; at the age of 40, 1 in 100 births; at 45, 1 in 40 births. Pregnant women above 40 years are thus the special high risk groups.

PATAU SYNDROME

This syndrome was described by K. Patau in 1960. It results when there is a trisomy of chromosome number 13. It can also be represented by its karyotype (47, +13). Patau syndrome occurs in about 1 in

Anthropology Paper 01 - Volume 01

20,000 newborns. It is rare in children and non-existing in adults because the severe symptoms result in early death. Most of the deaths occur within the first three months after birth, but a few victims have lived for as long as five years.

The symptoms of the syndrome include small brain, apparent mental deficiency, deafness and numerous other external and internal abnormalities.

EDWARD'S SYNDROME

It is first described by J.H. Edwards and his colleagues in 1960. It is the result of trisomy of chromosome number 18. Thus its karyotype is (47, +18).

The symptoms include mental deficiency and multiple congenital malformations involving virtually every organ system. Most infants with this syndrome die at an early age, some 90 percent within their first six months. Nearly all are deceased before they reach one year, but a few have been reported to be alive in their teen years.

The incidence of Edward's syndrome is 1 in 8000. Thus far, only a few cases have been observed, and it is not known whether racial or other population groups differ in incidence. In general, the incidence of this deformity is greater among infants of older women, as expected if the cause of this trisomy is primary nondisjunction in meiosis.

CRUI-DE-CHAT SYNDROME

This is a syndrome resulting from the deletion chromosomal aberration. Chromosomal deletions are usually lethal resulting in zygotic loss, still births, or infant deaths. Sometimes infants with small chromosome deficiencies, however, survive long enough to permit observation of some of the abnormal phenotypes they express.

3 L.Lejeune and his colleagues discovered a chromosome deficiency in humans that has been associated with the term Crui de chat syndrome. The name of this syndrome came from a plaintive catlike mewing cry from small weak infants with the disorder. Other characteristics are microcephaly (small head), broad face and saddle nose, widely spaced eyes with epicanthic folds, unique facial features, and physical and mental retardation. IQs of Crui de chat children studied are in the range of 20-40. The chromosome deficiency is in the short arm of chromosome 5 and is designated 5p-. A karyotype (46,XX,5p-) is represented for the patient.

✓ Crui de chat patients die in infancy or early childhood and do not transfer the chromosome deletion to offspring. This chromosome deficiency however has been shown by Lejeune and others to become involved sometimes in a reciprocal translocation and thus to be transmitted. When the short arm of chromosome 5 became translocated to chromosome 15, the heterozygous translocation was carried in a normal healthy parent.

GENETIC IMPRINTS IN HUMAN DISEASES

In order to have a better conceptual understanding on the concept of genetic imprinting, it is important to have a look back on Mendelism again. While discussing Mendelism, we have noted the experiment on pea plants. We have observed that a cross between a pure tall with a pure dwarf plant gives rise to heterozygous tall plant in the first filial generation. What we did not note then was which of the plants was a male and other was a female. Mendel wanted to know what could be the affect when a tall female plant was crossed with a dwarf male plant. The result was a tall plant in the first generation. He then wanted to observe the affect when sexes of the plants was reciprocated i.e., he crossed a tall male plant with a female dwarf plant and noted no difference in the phenotype of the offspring. On the basis of those observations, Mendel formulated the theory of equivalence. This theory says that there is no difference in the phenotype of the trait even in case of a reciprocal cross. Later this theory was extended to a number of plants and animals, including human beings.

Anthropology Paper 01 - Volume 01

However, it is to be noted that the law of equivalence is not universal. This law might be applicable to some genes within the same animal and may not be applied to other genes or chromosomes. Take for example, the sex-chromosomes in the human beings. The male sex chromosomes have a different phenotypic effect compared to the female sex chromosomes. Moreover, there are a number of genes which have "imprinted" or "stamped" sex markers, which is male or female, though they are responsible for a same trait. This leads to a situation where the gene for a same character from a female differ in behavior compared to the gene from a male. This situation is an exception to the law of equivalence and the phenomenon is called Genetic Imprinting. Genetic imprinting is also termed as Genome imprinting. It can be seen both in autosomes and sex chromosomes.

A clear understanding of the concept would be possible with an illustration. In the human beings there is an autosomal dominant disease called Huntington's chorea. Since it is dominant, any of two parents can suffer from this disorder. Hence, the source of the gene for the disease among the offspring can be paternal or maternal. It is observed that in both the cases of origin, paternal or maternal, the symptoms of the disease are same. However, there is a minor difference between the two cases of origin with respect to the behavior of the genes. It is observed that in case of paternal origin the time of initiation and severity of the disease vary when compared to the maternal origin. This proves the fact that though genes have similar structure and function they are differentially "stamped" or "imprinted" according to the source of origin. This is genetic imprinting. Thus, we can now define genetic imprinting as the differential inheritance of genetic material from the mother versus the father. It is an exception to the law of equivalence of Mendel.

Mechanism: One of the theories proposed to give an explanation of Genetic Imprinting is the Selective Methylation of DNA.

DNA Methylation is a usual process to control functioning of genes. This is brought about by an enzyme called DNA methylase. This enzyme adds a Methyl group (CH_3) to cytosine. If cytosine in one strand is methylated, it would pass through Guanine to the other strand.

(b) It has been discovered that the Genes coming from the mother are usually more methylated than the ones coming from the father. This degree of methylation of genes brings about qualitative and quantitative differences among them. This is the site of genetic imprinting. Excessive methylation results in inhibiting the activity of gene and thus is responsible for a number of disorders.

The concept of genetic imprinting suggests that in certain cases a genetic defect will only produce a phenotype if inherited from a particular parent. We will consider the most important diseases.

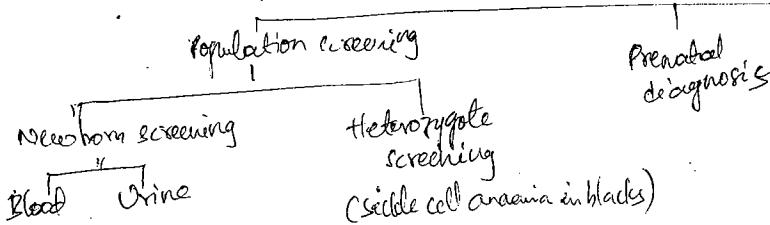
If there is a chromosomal deletion in a region concerned with placental development, it may have no effect if inherited maternally but may cause a failure of placental development if inherited paternally. The good examples of the above case are the Prader - Willi and Angelman syndromes. The Prader-Willi syndrome is caused by deletion of chromosome - 15, in position 11, 12 and 13, and is characterized by developmental delay, obesity and hypogonadism. The individuals with this syndrome are always derived paternally. In the case of Angelman syndrome, the deleted chromosome is always maternally inherited. The characteristics of disease are happy disposition, mental retardation, large mouth, protruding tongue and seizures.

Another genetic disease, hereditary Glomus Tumor is seen only in the individuals who have inherited the disease from their father.

Other examples - Albinism, Baldness.

5. Characteristics

1. Imprinted Genes Express Variously: The imprinted male and female genes can have different magnitude of expression and time of expression.
2. Genetic Imprints are Erasable: Imprinting is done in the Gonadal tissues, testes of a male and ovaries of a female. Such markings are erased during gamete formation in the ovary and testes of offspring and he or she stamps his or her marking on the genes.



Family screening (Research, Ex: Presymptomatic screening (Breast Cancer))

Anthropology Paper 01 - Volume 01

3. Gene Imprinting is not a Rule: This phenomenon is discovered only in some male and female genes. A majority of the genes are unimprinted, so that it is difficult to make any difference between male and female genes.
4. Genetic Imprinting is Species Specific: A gene imprinted in one species may not be imprinted in another.

Conclusion: The differences between maternally and paternally derived genes are significant in studying the differential inheritance. Genetic imprinting helps us to know the effect of deletions in different sexes and variation of the disease according to different sexes. A most recent discovery of a new disease due to this phenomenon is Myotonic dystrophy that affects the growing fetus.

GENETIC SCREENING ① is an experimental technique used to identify & select individuals who possess a specific genotype.

② Genetic screening may be used in populations at risk for a particular genetic disorder. Genetic screening is only appropriate when the natural history of the disease is understood; the screening tests are valid and reliable; sensitivity, specificity, false-negative, and false-positive rates are acceptable; and effective therapy is available. A sufficient benefit must be derived from a screening program to justify its cost.

1 Heterozygote screening: Screening a susceptible population (eg, Tay-Sachs disease in Ashkenazic Jews, sickle cell anemia in blacks, thalassemia in various ethnic groups) may be appropriate because of the high frequency of heterozygotes. Heterozygote screening can determine if a person is a carrier for a specific disorder. If the partner is also a heterozygote, the couple is at risk of having an affected child. Screening allows the couple to make informed reproductive choices.

2 Presymptomatic genetic screening: Presymptomatic genetic screening may be appropriate for persons with a family history of a dominantly inherited disorder (eg, Huntington's disease, breast cancer). Identifying a definite carrier of the genetic disorder may allow the patient to make informed decisions (eg, monitoring in the case of breast cancer, reproductive choices in the case of Huntington's disease or adult polycystic kidney disease).

3 Prenatal diagnosis: Amniocentesis (refer above), chorionic villus sampling, umbilical cord blood sampling, maternal blood sampling, maternal serum screening, and fetal visualization with ultrasound and radiography are useful in prenatal diagnosis. Common reasons for prenatal screening include maternal age > 35 yr, a family history of a condition that can be diagnosed by prenatal techniques, abnormal maternal serum screening results, and certain complications of pregnancy.

4 Newborn screening: Screening for phenylketonuria, galactosemia, and hypothyroidism in the newborn allows prophylaxis (i.e., special diet or replacement therapy) to be initiated early enough to prevent severe complications.

Thanks to S&T,

GENETIC COUNSELING Chromosomal abnormalities are sufficiently well understood today to permit Genetic Counselling

Genetic counseling consists of educating prospective parents either suffering from or suspected to be heterozygous for some genetic disease on the risk of their children suffering from the same disease. It is hoped that such parents would voluntarily abstain from producing children; this may be encouraged by creating a suitable social environment. It is relatively easy for a trained clinician to identify people suffering from a genetic disease. But identification of carriers for genetic disease is much more difficult and in many cases not possible. Analysis of family pedigree also provides information on the likelihood of an individual being a carrier for a genetic disease.

In a broad sense, Genetic counseling involves:

1. Genetic screening of a disorder and explanation to the patients or their parents the genetic or medical implications of the disease.

Steps in Genetic Counselling :-

① Pre-counselling Assessment
Ex: Diagnosis, Family History...

② Communication

Nature & consequence
of disorder
Treatment availability,
cost etc -

③ Follow-up
Written reports...

G.S. Kartic (karticsg@gmail.com) ② Recurrent Risk Estimation

- Burden of anxiety, costs, stigmatization are to be weighed against the need for detection
- Often screening test are misperceived as ~~diagnostically definitive~~. ~~This~~
Ex:- Some screening programs for sickle cell anaemia in 1970s were plagued by misunderstandings about the implication of carrier status. Occasionally, carrier detection led to cancellation of health insurance, employer discrimination etc.
- Hence there is a need for effective Genetic Counselling & public education.
- Right to privacy also has to be ensured

Anthropology Paper 01 - Volume 01

2. Calculation of the likelihood of recurrence of such genetic disorder in the family.

3. To suggest ways in which the occurrence of the genetic disorder can be controlled.

Embryo therapy
Patient therapy

Once genotypes of both the prospective parents become known, it is a simple matter to work out the probability of their child inheriting the disease. If parents heterozygous for a genetic disease decide to produce a child, it is now possible to advise them if their child has inherited the disease through appropriate tests done about two months after conception. This is achieved through amniocentesis; the cultured fetal cells may be used for determining their karyotype, levels of the critical enzymes and restriction patterns of DNA. Such an antenatal diagnosis is now feasible for more than 35 genetic diseases and for a variety of chromosomal defects. The purpose of such a diagnosis is premature termination of abnormal fetuses. This approach has helped to reduce the incidence of thalassemia from 30 to 2 per year in most of Europe. However, antenatal diagnosis may sometimes be misused. For example, it may be used to selectively abort fetuses of one sex. There were some newspaper reports that some parents in India are using amniocentesis to selectively abort female fetuses, obviously to save themselves from the hardships and sufferings they must face to arrange the exceedingly high amounts of dowry for their daughters. If such a practice becomes widespread, its consequences for the society should be obvious to even the most dimwitted.

Genetic counseling and antenatal diagnosis provide definite relief to the possible parents and reduce the frequency of genetically defective individuals in the population. However, it is unlikely that these measures would eliminate the deleterious alleles from a population. This is so because most genetic defects are recessive and heterozygotes for such alleles. Thus even after a total ban on reproduction by the homozygotes for such recessive alleles they would remain in the population through the heterozygotes; therefore even such an extreme selection would lead to only a slow decline in their frequency. Further, it is not likely that all the couples in any society will willingly submit themselves, at least in the foreseeable near future, to these procedures. But genetic counseling has become a routine aspect of medical practice in most developed countries.

It has been advocated that defective genes may be corrected through sophisticated genetic techniques either during the early stages of embryo development (embryo therapy) or in specific tissues of the adult patient (patient therapy); such an approach is referred to as genetic surgery. Embryo therapy would involve...

1. In vitro fertilization of egg
2. Production of several copies of the normal allele of the defective gene
3. Introduction of this DNA into the zygote or in the cells of the developing embryo
4. Integration of DNA, preferably in place of the defective allele, so that it may function normally.

Some of these steps have been tried in mice and rabbit and are being constantly refined. It is possible that embryo therapy may become practically feasible sometime in future, but its desirability is another issue for social debate.

The aim of patient therapy is to introduce the normal gene into the critical tissue of the patient that is affected by a genetic disease, i.e., the tissue where the concerned gene is required to express itself the most, e.g., pancreas in the case of diabetes. The steps involved in patient therapy would be similar to those of embryo therapy. But in this case, cells from the concerned tissues may have to be exercised and treated in vitro to correct their genetic defects and then reintroduced into the tissue where they may function normally. Techniques for isolation, identification and multiplication of many human genes are now available, and for many others they are likely to be developed soon. The techniques for gene transfer in eukaryotes are being refined and it may not remain a great problem in the near future.

A suggestion has also been made to use highly specific chemical mutagens that will correct the defect in the concerned gene. Such a directed mutagenesis however is a dream that may be more difficult to fulfill than patient and embryo therapies through DNA mediated genetic modifications.

(i) Failure to differentiate b/w neutral polymorphism & disease state
(ii) GC can be encouraged

- b) Genetic screening and counseling may also lead to certain problems. The cases of mistaken paternity, the problem of confidentiality, delayed counseling are important among them. Nevertheless, GC can be encouraged to create a equitable social environment because it
- 7 The various proposals on eugenics involve a number of religious, social, moral and political issues which have to be discussed and resolved. The issues involved in genetic surgery and in negative eugenics are relatively more straight forward than those involved in positive eugenics. For example, the concept of "superior type" is likely to vary from one society to another and even from one individual to another within the same society. More importantly, over a period of time, the same society may change its social concepts and values. This leads us directly to the discussion on genetics and bioethics.

HUMAN DNA PROFILING

DNA profiling is a series of DNA polymorphisms, usually VNTR (Very Large Insertion Deletion Repeats). Microsatellites typed in an individual. As these polymorphisms are highly variable, the combined genotypes are useful in identifying individuals. DNA (Deoxyribonucleic acid) is a chemical structure that forms chromosomes. A piece of a chromosome for forensic purposes that dictates a particular trait is called a gene.

Structurally, DNA is a double helix: two strands of genetic material spiraled around each other. Each strand contains a sequence of bases (also called nucleotides). A base is one of four chemicals (adenine, guanine, cytosine and thymine).

The two strands of DNA are connected at each base. Each base will only bond with one other base, as follows: Adenine (A) will only bond with thymine (T), and guanine (G) will only bond with cytosine (C). Suppose one strand of DNA looks like this:

A-A-C-T-G-A-T-A-G-G-T-C-T-A-G

The DNA strand bound to it will look like this:

T-T-G-A-C-T-A-T-C-C-A-G-A-T-C

Together, the section of DNA would be represented like this:

T-T-G-A-C-T-A-T-C-C-A-G-A-T-C

A-A-C-T-G-A-T-A-G-G-T-C-T-A-G

What is DNA Fingerprinting?

The chemical structure of everyone's DNA is the same. The only difference between people (or any animal) is the order of the base pairs. There are so many millions of base pairs in each person's DNA that every person has a different sequence.

Using these sequences, every person could be identified solely by the sequence of their base pairs. However, because there are so many millions of base pairs, the task would be very time-consuming. Instead, scientists are able to use a shorter method, because of repeating patterns in DNA.

These patterns do not, however, give an individual "fingerprint," but they are able to determine whether two DNA samples are from the same person, related people, or non-related people. Scientists use a small number of sequences of DNA that are known to vary among individuals a great deal, and analyze those to get a certain probability of a match.

How is DNA Fingerprinting Done?

1. Performing a Southern Blot

2. Making a Radioactive Probe

DNA probe is used to locate specific genes (or) sequences on the chromosome.

① Genomic Library

is prepared by partial digestion of total DNA of a genome by use of restriction endonucleases. These DNA fragments may be ligated to a vector to produce recombinant DNA molecules that can replicate in the host bacteria. The amplified DNA fragments representing the genome of a particular species constitute a genomic library.

3. Creating a Hybridization Reaction

4. VNTRs

② Complementary DNA library

contains only copies of DNA sequences that are present in mRNA molecules. These are prepared from mRNA which serves as template to prepare a complementary double stranded DNA using the enzyme reverse transcriptase. cDNA libraries contain relatively smaller DNA fragment compared to Genomic libraries.

Anthropology Paper 01 - Volume 01

It is estimated that Genomic library of *E. coli* has about 30,000 DNA fragments while man has about one million DNA fragments.

Southern Blot

The Southern Blot is one way to analyze the genetic patterns which appear in a person's DNA. Performing a Southern Blot involves:

1. Isolating the DNA in question from the rest of the cellular material in the nucleus. This can be done either chemically, by using a detergent to wash the extra material from the DNA, or mechanically, by applying a large amount of pressure in order to "squeeze out" the DNA.
2. Cutting the DNA into several pieces of different sizes. This is done using one or more restriction enzymes.
3. Sorting the DNA pieces by size. The process by which the size separation, "size fractionation," is done is called gel electrophoresis. The DNA is poured into a gel, such as agarose, and an electrical charge is applied to the gel, with the positive charge at the bottom and the negative charge at the top. Because DNA has a slightly negative charge, the pieces of DNA will be attracted towards the bottom of the gel; the smaller pieces, however, will be able to move more quickly and thus further towards the bottom than the larger pieces. The different-sized pieces of DNA will therefore be separated by size, with the smaller pieces towards the bottom and the larger pieces towards the top.
4. Denaturing the DNA, so that the entire DNA is rendered single-stranded. This can be done either by heating or chemically treating the DNA in the gel.
5. Blotting the DNA. The gel with the size-fractionated DNA is applied to a sheet of nitrocellulose paper, and then baked to permanently attach the DNA to the sheet. The Southern Blot is now ready to be analyzed.

In order to analyze a Southern Blot, a radioactive genetic probe is used in a hybridization reaction with the DNA in question. If an X-ray is taken of the Southern Blot after a radioactive probe has been allowed to bond with the denatured DNA on the paper, only the areas where the radioactive probe binds will show up on the film. This allows researchers to identify, in a particular person's DNA, the occurrence and frequency of the particular genetic pattern contained in the probe.

Making a Radioactive Probe

1. Obtain some DNA polymerase. Put the DNA to be made radioactive into a tube.
2. Introduce nicks, or horizontal breaks, along a strand, into the DNA you want to radiolabel. At the same time, add individual nucleotides to the nicked DNA, one of which is radioactive.
3. Add the DNA polymerase to the tube with the nicked DNA and the individual nucleotides. The DNA polymerase will become immediately attracted to the nicks in the DNA and attempt to repair the DNA, starting from the one end and moving toward the other end.
4. The DNA polymerase begins repairing the nicked DNA. It destroys all the existing bonds in front of it and places the new nucleotides, gathered from the individual nucleotides mixed in the tube, behind it. Whenever a G-base is read in the lower strand, a radioactive *C base is placed in the new strand. In this fashion, the nicked strand, as it is repaired by the DNA polymerase, is made radioactive by the inclusion of radioactive *C bases.
5. The nicked DNA is then heated, splitting the two strands of DNA apart. This creates single-stranded radioactive and non-radioactive pieces. The radioactive DNA, now called a probe is ready for use.

DNA libraries contain thousands (sometimes millions) of DNA fragments. It is extremely difficult to choose a DNA sequence of interest from among these. A group of molecules namely DNA probes are used to search the libraries for specific genes (or cDNAs). Probes are usually single stranded pieces of DNAs -

G.S. Kartic (karticsg@gmail.com) ¹⁵¹
 search the libraries for specific genes (or cDNAs). Probes are usually single stranded pieces of DNAs - sometimes RNAs), labelled with radio isotopes such as ^{32}P . The probes containing complementary base sequence (sometimes RNAs), are used to identify specific DNA fragments of DNA libraries. Southern blot / Northern blot techniques respectively are used to identify many genetic disorders.

It permits synthesis of millions of copies of specific DNA sequence in few hours. The source of target DNA may be from animal, plant, bacterium (or) virus.

② For PCR technique, it is not necessary to know nucleotide sequence of entire target DNA. However the 'flanking sequences' at each end of target DNA have to be known.

③ It is often regarded as cell-free molecular cloning.

④ Process :- (i) Denaturation of DNA (ii) DNA amplification - 25 cycles of PCR result in amplification of target DNA by million fold with high specificity
Anthropology Paper 01 - Volume 01

Creating a Hybridization Reaction

1. Hybridization is the coming together, or binding, of two genetic sequences. The binding occurs because of the hydrogen bonds between base pairs. Between a A base and a T base, there are two hydrogen bonds; between a C base and a G base, there are three hydrogen bonds.
2. When making use of hybridization in the laboratory, DNA must first be denatured, usually by using heat or chemicals. Denaturing is a process by which the hydrogen bonds of the original double-stranded DNA are broken, leaving a single strand of DNA whose bases are available for hydrogen bonding.
3. Once the DNA has been denatured, a single-stranded radioactive probe can be used to see if the denatured DNA contains a sequence similar to that on the probe. The denatured DNA is put into a plastic bag along with the probe and some saline liquid; the bag is then shaken to allow sloshing. If the probe finds a fit, it will bind to the DNA.
4. The fit of the probe to the DNA does not have to be exact. Sequences of varying homology can stick to the DNA even if the fit is poor; the poorer the fit, the fewer the hydrogen bonds between the probe and the denatured DNA. The ability of low-homology probes to still bind to DNA can be manipulated through varying the temperature of the hybridization reaction environment, or by varying the amount of salt in the sloshing mixture.

VNTRs

Every strand of DNA has pieces that contain genetic information which informs an organism's development (exons) and pieces that, apparently, supply no relevant genetic information at all (introns). Although the introns may seem useless, it has been found that they contain repeated sequences of base pairs. These sequences, called Variable Number Tandem Repeats (VNTRs), can contain anywhere from twenty to one hundred base pairs.

Every human being has some VNTRs. To determine if a person has a particular VNTR, a Southern Blot is performed, and then the Southern Blot is probed, through a hybridization reaction, with a radioactive version of the VNTR in question. The pattern which results from this process is what is often referred to as a DNA fingerprint.

A given person's VNTRs come from the genetic information donated by his or her parents; he or she could have VNTRs inherited from his or her mother or father, or a combination, but never a VNTR either of his or her parents do not have. Because VNTR patterns are inherited genetically, a given person's VNTR pattern is more or less unique. The more VNTR probes used to analyze a person's VNTR pattern, the more distinctive and individualized that pattern, or DNA fingerprint, will be.

Practical Applications of DNA Fingerprinting - Except identical twins, DNA profiles of 2 persons are never the same

1. Paternity and Maternity

Because a person inherits his or her VNTRs from his or her parents, VNTR patterns can be used to establish paternity and maternity. The patterns are so specific that a parental VNTR pattern can be reconstructed even if only the children's VNTR patterns are known (the more children produced, the more reliable the reconstruction). Parent-child VNTR pattern analysis has been used to solve standard father-identification cases as well as more complicated cases of confirming legal nationality and, in instances of adoption, biological parenthood.

(1)

(2)

a

④ To study Ecological & Pop genetics (to understand how diff species evolved over a period)

⑤ Biodiversity conservation - by establishing identity of various species

PCR has distinct advantages over the other traditional methods of recombinant DNA technique.

- PCR is highly sensitive, it can detect even the presence of single molecule of DNA.
- (i) Rapid diagnosis of infections, diseases (AIDS)
- (ii) Prenatal diagnosis of genetic diseases
- (iii) Detection of criminals in forensic medicine
- (iv) Study of evolution from DNA of archeological samples.

Anthropology Paper 01 - Volume 01

2. Criminal Identification and Forensics — (Burglary & Rape cases, Identification of the dead)

DNA isolated from blood, hair, skin cells, or other genetic evidence left at the scene of a crime can be compared, through VNTR patterns, with the DNA of a criminal suspect to determine guilt or innocence. VNTR patterns are also useful in establishing the identity of a homicide victim, either from DNA found as evidence or from the body itself.

3. Personal Identification

The notion of using DNA fingerprints as a sort of genetic bar code to identify individuals has been discussed, but this is not likely to happen anytime in the foreseeable future. The technology required to isolate, keep on file, and then analyze millions of every specified VNTR pattern is both expensive and impractical. Social security numbers, picture ID, and other more mundane methods are much more likely to remain the prevalent ways to establish personal identification.

Problems with DNA Fingerprinting

Like nearly everything else in the scientific world, nothing about DNA fingerprinting is 100% assured. The term DNA fingerprint is, in one sense, a misnomer: it implies that, like a fingerprint, the VNTR pattern for a given person is utterly and completely unique to that person. Actually, all that a VNTR pattern can do is present a probability that the person in question is indeed the person to whom the VNTR pattern (of the child, the criminal evidence, or whatever else) belongs. Given, that probability might be 1 in 20 billion, which would indicate that the person can be reasonably matched with the DNA fingerprint; then again, that probability might only be 1 in 20, leaving a large amount of doubt regarding the specific identity of the VNTR pattern's owner.

1. Generating a High Probability

The probability of a DNA fingerprint belonging to a specific person needs to be reasonably high—especially in criminal cases, where the association helps establish a suspect's guilt or innocence. Using certain rare VNTRs or combinations of VNTRs to create the VNTR pattern increases the probability that the two DNA samples do indeed match (as opposed to look alike, but not actually come from the same person) or correlate (in the case of parents and children).

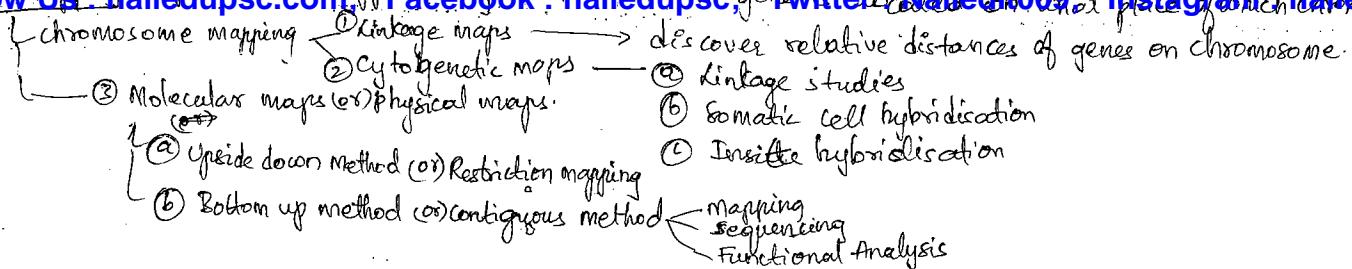
2. Problems with Determining Probability

A. Population Genetics

VNTRs, because they are results of genetic inheritance, are not distributed evenly across all of human population. A given VNTR cannot, therefore, have a stable probability of occurrence; it will vary depending on an individual's genetic background. The difference in probabilities is particularly visible across racial lines. Some VNTRs that occur very frequently among Hispanics will occur very rarely among Caucasians or African-Americans. Currently, not enough is known about the VNTR frequency distributions among ethnic groups to determine accurate probabilities for individuals within those groups; the heterogeneous genetic composition of interracial individuals, who are growing in number, presents an entirely new set of questions. Further experimentation in this area, known as population genetics, has been surrounded with and hindered by controversy, because the idea of identifying people through genetic anomalies along racial lines comes alarmingly close to the eugenics and ethnic purification movements of the recent past, and, some argue, could provide a scientific basis for racial discrimination.

B. Technical Difficulties

Errors in the hybridization and probing process must also be figured into the probability, and often the idea of error is simply not acceptable. Most people will agree that an innocent person should not be sent to jail, a guilty person allowed to walk free, or a biological mother denied her



Anthropology Paper 01 - Volume 01

Aids of Gene mapping

- ① Easy to diagnose a genetic disease.
- ② Can boost the frontiers of Gene therapy
- ③ Prevention of diseases
- ④ Possibility of a designer baby

legal right to custody of her children, simply because a lab technician did not conduct an experiment accurately. When the DNA sample available is minuscule, this is an important consideration, because there is not much room for error, especially if the analysis of the DNA sample involves amplification of the sample (creating a much larger sample of genetically identical DNA from what little material is available), because if the wrong DNA is amplified (i.e. a skin cell from the lab technician) the consequences can be profoundly detrimental. Until recently, the standards for determining DNA fingerprinting matches, and for laboratory security and accuracy which would minimize error, were neither stringent nor universally codified, causing a great deal of public outcry.

GENE MAPPING & GENOME STUDY

The Human Genome Project (HGP) was formally launched in October 1990 in USA. The project was co-sponsored by the Department of Energy (DOE) and the National Institute of Health (NIH). It was envisaged as a US\$3 billion, 15 year - effort. The completion of the first draft sequence or map representing about 90 per cent of the human genome was announced on June 26, 2000. The gigantic task has been accomplished a year ahead of schedule. It is undoubtedly a milestone in the march of sciences & technology. The then US President Bill Clinton has hailed it as "the most important and most wondrous map ever produced by humankind". The draft sequences will form the basis for obtaining the high quality finished sequence. It will also be a valuable tool for researchers hunting disease genes. A complete, high quality DNA reference sequence is expected to be achieved by 2003, two years earlier than originally envisaged. It may be achieved even sooner. In the year 2003 the 50th anniversary of unraveling of DNA structure by James Dewey Watson (1928) - and Francis Harry Compton Crick (1916) - will also be celebrated. It is expected that discoveries made based on the sequences will have profound impact on the better understanding of the state of good health and diseases. This information is likely to revolutionize the diagnosis, prevention and treatment of most, if not all, human diseases. Scientists in many countries are now engaged in developing tools and applications for the new data in such wide-ranging fields as medicine, agriculture, bioremediation and industrial enzymology.

The draft sequence is like a jumble of parts of a functional device - to make the device with a rough idea of how to assemble the parts. It contains gaps and errors. It provides scientists with a road map to an estimated 90% genes on every chromosome. All HGP data have been placed in the public domain (on the internet).

We will now briefly describe the concepts involved, genesis and implications of the HGP.

Genome may be defined as the complete genetic information carried by an individual or the range of genes found in a given species. The carriers of genetic information inside animal and plant cells are chromosomes, threadlike bodies. Chromosomes get their name from the fact that they take certain stains more heavily than do other parts of the cell, the term being derived from the Greek 'Chromos' (color) and 'soma' (body). Chromosome number is characteristic of a species. For example humans have 46 chromosomes, mosquitoes 6, frogs 26, earthworms 36, chimpanzees 48, amoebas 50 and horses 64. Human chromosomes comprise 22 matched pairs called autosomes and two sex chromosomes (X and Y). Every cell of our body has the same number of chromosomes except the reproductive cells (eggs are sperm), which have exactly half the usual number. Chromosome comes from both parents and a new individual life is formed by the fusion of two reproductive cells. Each chromosome consists of one very large strand of DNA (deoxyribonucleic acid) and proteins. The DNA is coiled and folded to produce a compact body. DNA, the chief constituent of chromosome, contains in chemically coded form, all the information needed to build, control and maintain a living organism. The structure of DNA, first proposed by J.D. Watson and F. H. C. Crick in 1953, is made of a double helix of two chains coiled around each other. Each chain is made up of alternating pentose sugar (deoxyribose) and phosphate groups, with an organic base attached to each pentose group. There are four possible bases: adenine (A), guanine (G), cytosine (C), and thymine (T). The bases join with each other by hydrogen bond to form base pairs that link the two strands of the DNA molecule like the rungs of a twisted ladder. The pairs are formed in a specific

Gene Mapping and Genetic Mapping

- fragments to chromosomes.
- Initially no mapping - with T in technology and mapping is perfect when DNA sequencing is completed.
- Mapping is used two diff ways of Mapping < Genetic mapping
Physical mapping - using molecular biology tech.
- Physical mapping - DNA cut by restriction enzyme; DNA fragments separated by electrophoresis
 - ↳ Genes can be mapped prior to complete sequencing by independent approaches like *In situ* hybridization

way; adenine links with the thymine and cytosine with guanine. Hereditary information is preserved from generation to generation as a specific sequence of bases. It is the bases (G, C, T and A) which form the letters of the genetic alphabet. A set of three bases called codon represents a particular amino acid, the building block of a protein. The particular order of As, Ts, Cs and Gs is extremely important because the order underlines all of life's diversity. In fact, this order directs whether an organism is human or another species. In a human genome about 3 billion bases are arranged along the DNA molecule in a practically infinite variety of sequence. The human genome can be seen as an incredible book written with 3 billion letters with four alphabets.

A functional unit of DNA corresponding to a specific sequence of the genetic code is known as a gene, a term first coined by W.L. Johannsen in 1909. Genes are the basic physical and functional units of heredity. Human genes vary widely in length, often extending over thousands of bases. Structural genes code for individual polypeptide while regulatory genes control the activity of the structural genes. Often the information content within a gene of higher organism may not be continuous. In such case different parts of a gene called exons are joined together after removing the unwanted sequences (introns) to make a continuous stretch of information in the form of messenger RNA molecule, which in turn is translated into a protein. Scientists do not know how many genes are there in the human genome. It used to be believed that the human genome has 100,000 genes. But recently this number has been questioned - predictions ranges from 30,000 to 1, 20,000 genes.

Till 1971 only 15 human genes had been localized to specific chromosomes. However, the ability to map genes was substantially increased with the development of the recombinant DNA technology particularly with the use of restriction enzymes to cut DNA molecules into small fragments.

The HGP was conceived by US Department of Energy (DOE). It was an outcome of the DOE's long-term mission to develop improved technologies for measuring; the effect of low level exposures to radiation and other energy related agents-especially the effect of such exposure on cancer risk. A brief outline of the project history is given below.

1984: The seeds of the HGP were sown in a conference at Alta, Utah. The conference jointly organized by the Office of the Health and Environmental Research of DOE and the International Commission for Protection against Environmental Mutagens and Carcinogens addressed a single question: "Does modern DNA research offer a way of detecting tiny genetic mutations - and, in particular, of observing any increase in the mutation rate among the survivors of the Hiroshima and Nagasaki bombings and their descendants".

1986: The office of the Health and Environmental Research of DOE initiated the process for considering the feasibility of a dedicated human genome program. An international conference was organized in March 1986 to assess the desirability and feasibility of implementing such a project. The participants agreed that ordering and eventually sequencing DNA representing the human genome were not only desirable but also achievable. The DOE initiated several pilot projects.

1987: The Health Effects Research Advisory Committee recommended in its report that DOE and the nation commit to a large, multi-disciplinary scientific and technological under taking to map and sequence the human genome.

1988: The US National Research Council (NRC) brought out a report entitled "Mapping and Sequencing the Human Genome". The NRC report recommended that the US support this research effort. This report also recommended a major role for the National Institute of Health (NIH). It also presented an outline for a multiphase plan. The NIH established the office of Genome Research in the Director's Office, which was upgraded to the National Centre for Human Genome Research in 1989 and subsequently the National Human Genome Research Institute. The US Congressional office of Technology Assessment (OTA) and the National Academy of Science studied the issue.

Disease Association \Rightarrow Process to identify a genetic element that signs responsible for a disease is also referred to as "mapping".

Goals of HGP

- Map the entire human genome.
- Determine the complete sequence of the 3 billion base pairs that make up human genome or defines the human species.
- Identify all the genes in human DNA. (approx. 80,000 genes)
- Store this information in database.
- Develop tools for data analysis.
- Address the ethical, legal and social issues resulting from the project.

All organisms are related through similarities in DNA sequence and so understanding of the functioning of non-human genomes, often lead to new knowledge about human biology. As a part of the HGP the scientists are also carrying out parallel studies of several non-human organisms like the common human gut bacterium, Escherichia coli, the fruit fly and the laboratory mouse.

Though the HGP started as US project it has become a worldwide research effort. The "Universal Declaration on Human Genome and Human Rights" by the UNESCO recognizes that research on human genome and the resulting capabilities and research would open up immense prospects for the whole humankind. Today, some 17 countries are participating in the project. The USA, the country which initiated the project, is playing a major role. Significant contributions are coming from the Sanger Centre in the United Kingdom and research centers in Germany, France and Japan. The other countries are: Australia, Brazil, Canada, Denmark, Israel, Italy, Korea, Mexico, The Netherlands, Russia and Sweden. European Union is also taking part in the project. A considerable amount of financial support for the project is coming from the private companies. The Muscular Dystrophy Association of France and the Wellcome Trust of the UK are also supporting the project. Some developing countries including India are directly or indirectly participating through studies of molecular biology techniques for research and studies of region specific organisms. The Indian contribution to the genome analysis programs is not very significant.

An international organization, the Human Genome Organization, (HUGO), was established in Geneva, Switzerland in 1988 with the following objectives:

- "To assist with the co-ordination of research on the human genome and in particular to foster collaboration between scientists with a view to avoiding unnecessary competition or duplication of efforts and to co-ordinate this research with parallel studies in model organisms."
- "To co-ordinate and to facilitate the exchange of data and biomaterials relevant to human genome research and through training program, encourage the spreading of the related technologies".
- "To encourage public debate and provide information and advice on the scientific, ethical, legal and commercial implication of human genome project".

Criticism

When the project was first announced there was a big hullabaloo. Among the critics were prominent molecular biologists. Some of the objections raised by the critics were:

- The project was viewed as colossal waste of time, money and human resources on a monotonous, technology-driven exercise.
- The mega project would take major chunk of already scarce research funds away from the traditional small science of individual investigator-initiated research projects.

4 major priorities:

- (1) Issue of privacy & fairness in use & interpretation of genetic info.
- (2) Clinical integration of new genetic technologies (Are health professionals adequately educated about genetics?)
- (3) Commercialization of human genetic research
- (4) Education of general public & health care providers

Anthropology Paper 01 - Volume 01

- The complete sequence of each gene is simply unnecessary and tedious. The search for disease genes may be accomplished by approaches without involving arduous task of complete sequencing.
- Most part of the genome may simply be evolutionary baggage with no useful function.
- A host of ethical, legal and social issues were also raised: Who should have access to the genetic information? If handled carelessly genetic information could threaten us with discrimination by potential employers and insurers. How are we going to ensure privacy and confidentiality of genetic information! Personal knowledge of genetic susceptibility can make it possible for more accurate diagnoses, preventive interventions, intensified screening, life-style changes and early and effective treatment. But then there is the risk of anxiety, unwelcome changes in personal relationships and danger of stigmatization. How are the "products" of HGP to be patented and commercialized!
- How are the judicial, medical, education communities and the general public to be effectively educated about the implication of HGP? To address the ethical and other social issues the NIH-DOE joint Working Group on Ethical, Legal and Social Implications of Human Genome Research was created in 1990.

But there are also strong supporters of the project. Some of the arguments in favor of the project are:

The project has been likened with the American drive to put a man on the moon during the 1960's. It was projected as panacea for all diseases. It would be possible to unveil and eventually to subvert, the causes of thousands of human diseases. "It represents nothing less than the ultimate scientific response to the Socratic dictum "know thyself" - Professor James Trefil of George Mason University.

Benefits → (i) Molecular Medicine, (ii) Waste Control, Environmental Cleanup (iii) Biotechnology (iv) Energy Sources

(v) Risk Assessment

- (1) Technology and resources developed by the HGP will make possible for identifying the most fundamental causes of diseases. Earlier detection of genetic predispositions to diseases will be possible by virtue of rapid, improved and more specific diagnostics tests. Greater understanding of genetic predisposition to disease will also make possible avoidance of environmental conditions that may trigger diseases. It has been projected that eventually it would be possible to find out that genetic disease a person is at risk for and fix it by putting in a gene of appropriate sequence.
- (2) Taking advantage of new capabilities and resources developed by the HGP studies for sequencing the genome of bacteria useful in energy production, environmental remediation, toxic waste reduction and industrial processing have already been initiated. It will be possible to explore new energy sources.
- (3) It will be possible to assess health damage and risks caused by radiation exposure (including low-dose exposure), mutagenic chemicals and cancer-causing toxins. The likelihood of heritable mutations can be reduced.
- (4) As a part of HGP the scientists are also studying the genomes of other organisms. Such competitive studies will enable scientists to ascertain the function of thousands of unknown genes. It will be possible to develop new insights about human evolution and the relationship among the three kingdoms of life—archaea-bacteria, eukaryotes and prokaryotes.
- (5) The knowledge generated by the GP will help in environmental protection by detecting bacteria and other organisms that may pollute air, water, soil and food.
- (6) It will be possible to develop disease, insect and drought resistant crops.
- (7) Healthier, more productive, disease-resistant farm animals will be developed.
- (8) Bio-pesticides will be developed.

Anthropology Paper 01 - Volume 01

The project has both positive and negative aspects just like in the case of atomic energy. There are many disturbing issues, which need to be resolved but then there are also immense possibilities which humankind may exploit for a better future. The draft sequence of the human genome is the beginning of a biological revolution. The practical and economic applications of the HGP are destined to usher in dramatic growth. Its impact that will be felt in medicine and health care alone is inestimable. But then the DOE report states: "The genome project itself offers no promises of cancer cures or quick fixes for Alzheimer's disease, no detailed understanding of genius or schizophrenia. But if we are ever to uncover the mysteries of carcinogenesis, if we are ever to know how biochemistry contributes to mental illness and dementia, if we ever hope to really understand the processes of growth and development, we must first have a detailed map for the genetic landscape. That's what the Human Genome Project promises. In a way, it's rather prosaic step, but what lies beyond is breathtaking".

Thrifty & Non-thrifty genotype: Advent of agric (ushered) a long era of nutritional deficiency for most people.

- ① 1962 - James Neel introduced idea of TG - a genotype that is very efficient at storing food in form of fat. After observing many non-western pop. that have recently adopted western diet were much more likely than western pop. to have high incidence of obesity, diabetes
- ② Pop such as Pima Papago in south west USA have diabetes rates of about 50%.
- ③ Elevated rates of diabetes observed in Pacific Island, Asian, African derived pop with largely western diet.
- Acc. to Neel, Hunter-Gatherers needed a thrifty genotype to adapt to their non-abundant nutritional environments. In contrast, TG is selected in nutrient abundant European envt through negative consequences of diabetes & obesity.
- History of agric & nutritional availability in Europe makes the evolution of non-thrifty genotype unlikely. Europe was no more nutritionally favoured than other agric & hunter-gatherer pop.
- However the notion of thrifty genotype retains viability.
- Gerber & Truce proposed refinement & expansion of TG model called Thrifty Pluri-trophic model. Nut concentrated primarily on energy intake but G&T point out that TG should apply to any nutrient in envt that is (or) was potentially scarce. Thus we should expect -ve health consequences for overconsumption of various nutrients. Ex- Excess cholesterol - heart salt - BP.
- The deficiency syndrome of age is part of this adaptive balance. Too little of nutrient can lead to disease.
- The pluri-trophic aspect of G&T model is based on observation that most of diseases is associated with _____. are chronic illness that have effect late in life & to some extent are responsible for ageing.
- If the efficiency of TG increases reproductive fitness early in life, the -ve consequences in middle & old age will not be selected against even in envt of nutritional abundance.

Thrifty Genotype hypothesis - proposed by James Neel to resolve a problem "How disease (diabetes) with a likely genetic component & with such -ve effects may have been favoured by process of natural selection?"

- TG would have been adv for hunter-gatherer pops, esp childbearing women, coz it would allow them to fatten more quickly during times of abundance. Fatter individuals carrying TG would better survive times of food scarcity. However in modern societies with constant abundance of food, this genotype efficiently

G.S. Kartic (karticsg@gmail.com) prepares individuals for famine that never comes. The result of this mismatch btw envt in which brain evolved & envt of today is widespread chronic obesity & related Jnly health problems like diabetes.

Join Us : Telegram : <https://t.me/nailedupsexam>

Racism in India; Raid against African women; Torture of Dalits

- Racism occasionally manifests in form of hatecrime.

(Page - 16 Target Notes)

Race - Archaic hominids (Grimaldi, Chancel & Coqueray) gave rise to 3 distinct racial elements.

Anthropology Paper 01 - Volume 01

9.5 RACE AND RACISM (Dobzhansky)

CONCEPT OF RACE - D.N. Marples: Race is a group of people who by their possession of a number of common physical traits can be distinguished from others, even if the numbers of this biological group are widely scattered. Theodosius Dobzhansky, the pioneering researcher on Reproductive isolation has defined race as a "group of population which is reproductively isolated to the extent that the exchange of genes between them is absent or so slow that the genetic differences are not diminished." Implied in this definition are four features of a race.

1. Group of Population: All populations have their own gene pool with differing gene frequencies. If race is defined in terms of gene frequencies, all populations would qualify to be called a race. Race is higher in hierarchy than populations, and consists of many populations that have gene frequencies related to one another.
2. Genetic Differences: The group of populations forming a race has some genes in very high frequency and some in very low frequency and these genetic differences characterize a race. Such differences in gene-frequency arise partly because of natural selection and chance.
3. Repproductively Isolated: The group of populations forming races is reproductively isolated. This isolation maintains the genetic differences. This isolation is however, not complete. Whenever races expand their range and come into contact of other races, they potentially hybridize and a new gene frequency is set up.
4. Race is a Biological Concept: Race is different from religious, political or cultural groups. Race is purely a biological concept and occurs not due to any cultural superiority but genetic differences.

RACE & RACISM - Article by Samuel Morton 'The Mismeasure of Man' - blow to racial studies in A.R. Stephen Jay Gould - 'concept of race is misleading & results in abominable feature of Racism'. Since the development of the concept of race, it has been subjected to a lot of controversy. For some, it exists as a biological phenomenon and for others as a cultural one. To better understand the controversy, we shall see both the connotations of the term "Race".

Race as a Biological Concept

As a device for understanding

Racism is a belief that certain races are inferior to some other races.

Biological Definition To understand why the racial approach to human variation has been so difficult, we must first understand the race concept in strictly biological terms. Briefly, a race may be defined as a population of a species that differs in the frequency of some gene or genes from other population of the same species. Simple and straightforward though such a definition may seem there are three very important things to be noted about it. First, it is arbitrary - there is no agreement on how many genetic differences it takes to make a race. For some people, differences in the frequency of one gene are sufficient, while for others, differences in frequencies of several genes are necessary. The number of genes and the ones needed to make a race are still open to debate.

2 The second thing to note about the biological definition of race is that it does not mean that any one race has exclusive possession of any particular gene or genes. In human terms, the frequency of the gene for blood group 'O' may be high in one population and low in another, but it is present in both. Races are genetically "open", meaning that gene flow takes place between them. Thus one can see the fallacy of any attempt to identify "pure" races; if gene flow cannot take place between two populations, then they are not races, they are separate species.

3 The third thing to note about the biological definition of race is that individuals of one race will not necessarily be distinguishable from those of another. In fact, as we have just noted with respect to humans, the differences between individuals within a population may be greater than the differences between populations. This follows from the genetic "openness" of races; no one race has an exclusive monopoly on any particular gene.

④ Next page

G.S. Kartik (karticsg@gmail.com)

According to Kroeber "Race is a valid biological concept: a group united by heredity, a genetic strain (or) sub-species and not at all a valid socio-cultural concept."

(4) As blood groups, body fat & growth patterns to Caucasoids than other black groups.

Anthropology Paper 01 - Volume 01

✓ As a device for understanding human variation, the biological race concept has serious drawbacks. One is that the category is arbitrary to begin with, which makes agreement on any given classification difficult. Perhaps if the human species were divided into a number of relatively discrete breeding populations, this would not be such a problem, but even this is open to debate. What has happened though is that human populations have grown in the course of human evolution, and with this growth has gone increased chances for contact and gene flow between populations. Since the development of food production, which began about 10,000 years ago, the process has accelerated so that differences between human populations today may be less clear-cut than back in the days of Homo erectus, or even the Neanderthals.

If this is not enough of a problem, things are complicated even more because humans are so complicated genetically. Thus the genetic underpinnings of phenotypic traits that traditionally are the subject of racial studies are often poorly understood. To compound the problem, "race" exists as a cultural, as well as biological, category. In various different ways, cultures define religious, linguistic, and ethnic groups as races, thereby confusing linguistic and behavioral traits with physical traits. They also adopt emotional attitudes toward them.

✓ A major result of all this has been a lot of debate about what "race" is and is not, as well as the number of human races that can be defined. Often forgotten is the fact that a race, even if it can be defined, is the result of the operation of evolutionary processes. Because it is these processes rather than racial categories themselves in which we are really interested, a growing number of anthropologists have become convinced that the race concept is of no particular utility. Instead, they prefer to study the distribution and significance of specific, genetically based characteristics, or else the characteristics of small breeding populations that are, after all, the smallest meaningful units in evolution.

Race as a Cultural Concept

① Race exists as a cultural as well as biological category.
 Why has it been impossible to agree upon a definition of race? The answer to this question lies in the fact that the radical racial categories people use are often very revealing indicators of their social values. The way in which we see other people is culturally conditioned. Recognizing the race of another is something we learn in the process of growing up in a particular culture. Some cultures recognize many more shades of skin color than do Americans, who tend to dump people into the categories white and black. Brazilians have about 500 different racial labels (Kottak, 1974), each level corresponding to some phenotypical trait. Because the gradations are so subtle, one individual may have several different racial labels during the course of his or her lifetime.

④ Concepts of race are so ambiguous and so much a product of cultural bias that race, as the term is traditionally used, has no clear biological meaning. Thus, by using the term, one runs the risk of having it interpreted in ways that were not intended. No anthropologist would deny that race is an important way of organizing human variation in cultural terms. But culturally defined categories cannot be translated into objective, clear, biological categories. For this reason, physical anthropologists are gradually abandoning the use of racial categories in studying human variation.

Conclusion
 ✓ Relevance of the Concept of Race Today (Concept of race has become a myth, not a reality)
 As a device for understanding human variation, the biological concept of race has serious drawbacks. The biological and scientific reasoning behind the conception of race is today sadistically trashed. The objective and scientific reasoning behind the biological concept of race is increasingly substituted by subjective and unscientific bases of culture. The growth of "Racism" in recent decades on the basis of cultural and intellectual superiority has led to the new concept of "ethnic cleansing" as seen in former Yugoslavia. People are being increasingly differentiated on the basis of unscientific concepts like "purity and superiority of blood", "fine color", "superior mental and physical abilities" and "cultural superiority".
 4 In other words, race and concept of race has paved the way for ethnocentrism.

→ In 1952, the UNESCO has made a declaration regarding the concept of race.

1. All human beings belong only to one species - Homo sapiens.

R3 Acc. to DN Majumdar & Franz Boas - Racism is result of certain intelligent & shrewd

G.S. Kartic (karticsg@gmail.com)

political groups with high ambitions, using a trivial & flimsy concept of race & giving it a huge colour of racial stratification.

Anthropology Paper 01 - Volume 01

2. There is no doubt some differences in the physiological anatomy either because of hereditary trait or environment but generally both affect it.
3. The change in heredity is because of mutation or cross marriage.
4. Race cannot be grouped on the basis of nationality, religion, geographical, cultural and linguistic factors.
5. The present day classification is based on anatomical and morphological differences and not on any ground of inferiority and superiority.
6. Intelligence does not play any role in classification of the races.
7. Culture differences are not the cause of racial differences.
8. The so called "pure races are no where to be found either these days or in the past". There has been intermingling of races going on.
9. The human beings are equal and they deserve equal treatment.

Owing to these difficulties in comprehending the scientific objectivity and failure to translate them into objective facts, the concept of race is being abandoned today. Of late, the concept of race has only become a myth and not a reality.

BIOLOGICAL BASIS OF MORPHOLOGICAL VARIATION OF NON-METRIC AND METRIC CHARACTERS

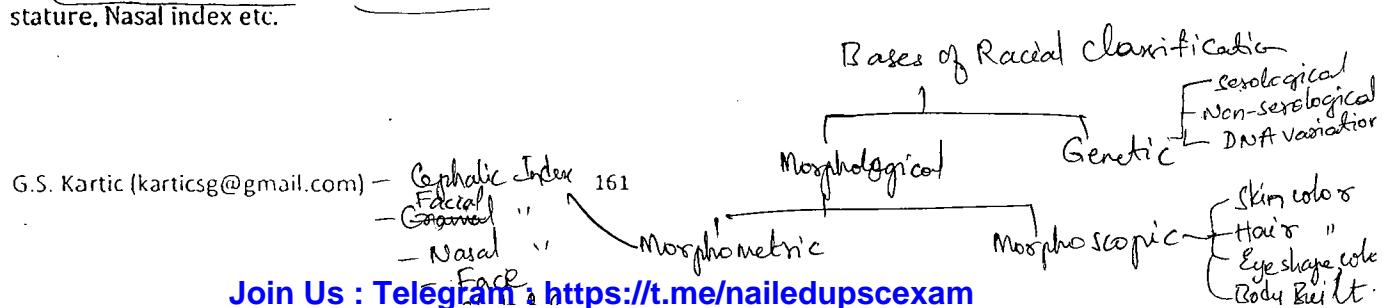
The most noticeable biological variations among human populations are those which are on the surface. They are also many biological variations we do not see. Certain of these variations may be explainable as adaptations to differing physical or social environment or as consequences of other physical or cultural changes. According to Boyd, a criterion or a base which is selected for classifying the human populations into various races should fulfill the following conditions:

1. The parameter should be objective without any bias of individual variations.
2. The criteria should be least or should not be influenced by the environment; that is the parameter chosen should be non-adaptive.
3. The parameter or the criteria should not undergo mutations.
4. The genetic principles of the character which is considered for the racial classification should have known genetic principles, which mean it should be inherited in a Mendelian pattern.

The criteria which are chosen for the racial classification to a majority are phenotypic in nature. These criteria are the morphological bases of racial classification. There are other criteria which have the physiological characters with well-known genetic principles. These characters are the serological or genetic bases for the racial classification.

MORPHOLOGICAL CRITERIA

The morphological criteria can be anthroposcopic or morphoscopic, in the sense that the parameters can be discriminated on the basis of vision. For e.g., skin color, nose form etc. A morphological character can also be anthropometric or morphometric in the sense that the parameter is measurable. It includes stature, Nasal index etc.



I. SKIN COLOR

Human populations differ in average skin colour. Many people consider skin colour as the most important indicator of racial distinction. But anthropologists note that skin colour is not a good indicator of race.

For e.g. extremely dark skin is found most commonly in Africa. However there are natives of Southern India whose skin is as dark as or darker than that of the Africans. Yet these people are not closely related to Africans either genetically or historically.

Nevertheless, the very fact that there are people in the world with the markedly different skin colours leads us to the question of how we can explain this wide range of hues. We now know that skin colour is influenced by a pigment called Melanin. The more Melanin there is in the skin, the darker the person will be. Furthermore, the amount of melanin in the skin seems to be related to the climate in which a person lives. According to Glöger, the populations of birds and mammals living in warm, humid climates have more melanin than do populations of the same species living in cooler, drier areas. Dark pigmentation seems to have at least one specific advantage in the tropical climate. Melanin protects the sensitive inner layers of the skin from the sun's damaging ultra-violet rays. Therefore dark skinned people living in sunny areas are safer from sun-burn and skin cancers than light skinned people. Presumably the light coloured skin must be having some benefits; otherwise, through the process of natural selection human populations would all tend to have relatively dark skin colour. Although the light skinned people are more susceptible to sun-burn and skin cancer, light skin absorbs the ultra-violet radiation which facilitates the body's production of Vitamin-D. Thus the light colour of people in temperate latitudes maximizes ultra-violet penetration, perhaps ensuring production of sufficient amounts of Vitamin-D for good health, whereas the darker skin of people in tropical latitudes minimizes it, thereby preventing illness from too much of production of Vitamin-D.

The population of the world can be classified into three groups on the basis of skin colour.

1. **Leucoderms:** The leucoderms are the white-skinned people. Apart from the Europeans, who form the best example for this skin color, the Western Asiatics, the North Africans, and Polynesians are the other examples. Caucasoids are also included in this group.
2. **Xanthoderms:** The xanthoderms are the yellow skinned people. For example, Mongoloids, Armenoids etc.
3. **Melanoderms:** Melanoderms are dark skinned people and the dark color can be accounted to abundant deposition and profuse diffusion of melanin and hence the name. For example, The Negroid.

II. HAIR

Hair is one of the most important criteria applied for racial classification. In fact it is one of the oldest criteria employed for this purpose. The criterion of hair can be further divided into various characteristics conveyed by it. These are the form, colour, texture, quantity, cross-section, and hair whorl.

1. **HAIR FORM:** Depending upon the form of hair, three broad groups can be identified.

- a) Leiotrichy or Straight Hair - Mongoloids.
- b) Cymotrichy or Wavy Hair - Peoples of West Asia, some parts of Africa and Europe.
- c) Ulotrichy or Woolly Hair - Negroes, Andamanese, Bushmen, and Melanesians etc.

It has been noted that the climatic or the environmental conditions influence the hair form. A moist and a warm climate is said to be responsible for woolly hair, whereas the dry and a cold climate is

responsible for straight hair. But many anthropologists are in a view that climatic conditions do not influence the hair form.

2. HAIR COLOUR: A wide range of colours are exhibited by hair. The colour of the hair is because of the presence of pigments present in the cortex of the hair. The range of colour extends from dark hair to light or white hair. Environment is said to have no effect at all on the colour of the hair. Among the North Europeans the colour of the hair ranges from light brown to red. Some Negroid populations in Africa and Melanesia possess hair with a yellow tinge. The oceanic Negroids possesses dark red hair and blonde hair is found only among the people of Europe in the Baltic area.
3. HAIR TEXTURE: Based on the texture of the hair, it can be divided into coarse hair, medium hair or fine hair. The thickness of the hair ranges between 5 - 125 microns. According to Garn, hair can be classified accordingly.

Fine hair - 56 microns

55

where are they found?

Medium hair - 57 - 84 Microns

85

Coarse hair - 85 and above Microns

4. QUANTITY: The quantity of the hair on the head can be further divided into following types based on the amount of hair present:

- a) SCANTY
- b) MEDIUM
- c) THICK
- d) VERY THICK
- e) RICH

This criterion is an anthroposcopic or morphoscopic criterion since it can be ascertained visually by mere observation. One point to be noted is that when the quantity of hair is being considered, the quantity of hair on the various portions of the body should also be taken into account.

5. CROSS SECTION: Based on the cross section of hair, it can be classified into Circular or Oval. The circular cross section can be noticed among the hair of the Mongoloids and an oval cross section can be observed among the Negroids. This criterion is very rarely considered for the purpose of racial classification.
6. HAIR WHORL: The occiput of the head reflects the whorls of the hair. The hair whorls can be either Clock Wise or Anti-Clock Wise. Though possession of one whorl is common in one individual, rarely more than one whorl in a single individual can also be observed.

III. STATURE

Scientists have suggested that the body build of many mammals may vary according to the temperature of the environment in which they live. According to Bergmann, the smaller size populations of a species inhabit the warmer part of its geographical range and the large size populations inhabit the cooler areas. The rationale behind this theory is that the long limbed body type that is often found in tropical region provides more surface area in relation to body mass and thus facilitates the dissipation of body heat. In contrast, the chunkier short limbed body type found among the residents of cold regions help to retain body heat by reducing the amount of surface area to body mass. It is not clear, however, whether

Anthropology Paper 01 - Volume 01

differences in body build between populations are due solely to natural selection or different conditions of cold or heat. Some of the variations may be induced during the life-span of the individual.

Although the adaptation to heat and cold may have some effect on the varying height of human populations, such variation may also be produced by other conditions. Physical or psychological stress, nutrition, medical care and other factors unrelated to temperature may affect the human stature. As a result of our increased social and geographic mobility, mating between different kinds of people are fairly common now-a-days across cultures and continents. Increased height in the off-springs of these matings may be partially a consequence of the hybrid vigour so produced.

According to the general scale of stature, the following list is tabulated.

CATEGORY	MALE (cm)	FEMALE (cm)
Very Short	0 - 150	0 - 140
Short	150 - 160	140 - 159
Medium	161 - 170	151 - 159
Tall	180 - 185	168 - 178
Very Tall	186 +	178 +

IV. HEAD FORM

The head form can be expressed in three indices - Cephalic index, Length-height index and Breadth-height index. It was Anders Retzius, who noted that there was a great deal of variation in the head form among different races. He decided that the shape of the head was an important criterion for classifying the people.

$$\checkmark \text{ Cephalic Index} = \text{Breadth of Head} / \text{Length of Head} \times 100$$

According to Broca, the following is the classification of the head forms depending upon the Cephalic index:

TYPE	CEPHALIC INDEX
Dolicocephalic	- 75.00
Sub-dolicocephalic	75.01 - 77.77
Mesaticephalic	77.78 - 80.00
Sub-brachycephalic	80.01 - 83.33
Brachycephalic	83.34 - +

Broca's scale of classification is not widely accepted because his calculations are based on the measurements he has taken on a skeletal skull, when actually for thickness the epicranial tissues are to be considered for this calculation.

The following is the classification based on Joseph Denicker's scale.

TYPE	CEPHALIC INDEX
Hyper-dolicocephalic	< 76
Dolicocephalic	+1 to +1
Sub-dolicocephalic	+
Mesaticephalic	+
Sub-brachycephalic	+
Brachycephalic	+
Hyper-brachycephalic	+

There is much of ambiguity and debate regarding the cephalic or head form for the purpose of racial classification. Moreover, since the recent discovery that head form to some extent is determined by birth, this criterion for racial classification is considered to be of secondary importance.

V. FACE FORM

Like the stature, the facial structure may also be affected by environment. This was proved by the experiments conducted on rats by Reisenfeld. Temperature related effects are also evident in the structure of human faces. The people living in cold climates have higher, narrower noses, than warmer regions. This difference may be due to low absolute humidity associated with cold air rather than with cold itself. A relatively narrow nose may be more efficient humidifier and heater of cold air than a broad nose.

Faces are of different shapes - round, oval, square, etc. For scientific purposes, faces have been classified on the basis of facial index. It is calculated as given below:

$$\text{Facial Index} = \frac{\text{Morphological facial length}}{\text{Bzygomatic breadth}} \times 100$$

TYPE	CEPHALIC INDEX
Hyper Euryprosopic	- 78.90
Euryprosopic	79.00 - 83.90
Mesoprosopic	84.00 - 87.90
Leptoprosopic	88.00 - 92.90
Hyper Leptoprosopic	93.00 - +

There is a harmonic relation between the face and the head. A long face is generally associated with long head while a Brachycephal has a broad face. But in some cases exceptions are noticed in these arrangements. This condition is known as disharmony. The Cro-Magnon people in the history possessed this type of disharmonic face. The condition of long head and broad face is generally seen amongst the Eskimos.

VI. JAW PROFILE

The lower jaw shows a varying degree of conditions - Prognathism is the condition in which the lower jaw is protruded outwards and downwards as in the Negroids. When the face does not show any trace of protrusion, it is known as Orthognathism. Sometimes the alveolar regions of the upper and lower jaw project forward and these conditions are known as Alveolar Prognathism. The modern people are characterized by orthognathism.

VII. NOSE FORMS

Three different morphological conditions can be considered with regards to the nose.

Nasal Index: Nasal index can be calculated by the following formula

$$\text{Nasal Index} = \frac{\text{Nasal breadth}}{\text{Nasal length}} \times 100$$

NOSE TYPE	SKELETAL MEASUREMENT	LIVING FORM MEASUREMENT
Leptorrhine (Caucasoid)	... - 47.9	... - 70.0
Mesorrhine (Mesorrhine)	48.0 - 52.9	71.0 - 84.9
Platyrrhine (Negroid)	53.0 - +	85.0 - 99.0

Nasal Root: Nasal root is the junction of nasal bones with the frontal bones of the skull. It bears a depression of varying depth. It is of three kinds - low, medium and deep.

Serological Criteria

- (1) Blood groups
- (2) HLA
- (3) Hb → HbS
HbC
Thalassemia
- (4) Blood proteins ← Tf
Hp
IgG.
- (5) ABO
- (6) Rh
- (7) MNs
- (8) Duffy
- (9) Kidd

- (1) Rollers (Mendelian character)
- (2) Phenyl Thio Carbamide - Tasting Ability
- (3) DNA polymorphism
- (4) Dermatoglyphics

Anthropology Paper 01 - Volume 01

Nasal bridge: The two nasal bones join laterally all along their lengths. Both bones are rectangular in shape. They thus form an angle while they join with each other. This is the nasal bridge.

The Nasal Profile depends upon nasal bridge and roots. The various profiles are: Straight, Concave, Convex or Concavo-Convex.

Narrow and broad nasal bridges are found in primitive human groups. Negroes have depressed root with a broad bridge. Australians have much lower root than Negroid, their bridges are also much low and narrower. Caucasoids have the highest bridge.

SEROLOGICAL AND GENETIC CRITERIA

In this section, we shall begin with a discussion of the genetically determined bio-chemical characteristics in which different individuals in the same population - indeed, different members of the same family - often differ from one another. These differences are of interest genetically, anthropologically, and from an evolutionary perspective because they reflect the presence or absence of the same genes.

Simple, genetically determined bio-chemical variations can be identified and counted within populations and populations can then be compared in respect to the frequencies of the genes which determine these variants. The development of this branch of human genetics has resulted from the importance of biochemical variants in medicine. Anthropologists do not often focus on the frequently complex relationships of genetic variations to health and disease. Usually, they seek common variants of known or unknown pathological significance, which if they occur, can be used to trace the historic connection between people.

SEROLOGY

We know by the traditional methods of Physical anthropology, and even from casual observations that main characteristics such as skin colour, nose size and hair form differ among human groups. But in structures such as skin, nose and hair, genetic potential is expressed to a varying extent and is different throughout the course of development. The relationship between them can be traced through a particular base sequence in the DNA of a chromosome and the end result can rarely be identified in the genetics of these quantitative characteristics. On the other hand, through Serology, the examination of components of blood specimens, it is possible to identify very small qualitative differences.

Blood is a complex substance. If it is collected in a syringe and allowed to stand, it separates into two parts. First, a reddish mass composed of red blood cells and of fibrinogen that causes them to clot and second, a clear yellow fluid blood-serum. However, if a chemical which prevents clotting is added to a fresh specimen and the blood is then separated into components by spinning it in a centrifuge, fibrinogen and the serum remain together and constitute blood plasma, while the red cells collect at the bottom of the tube. There is also a thin third layer composed of the white cells. All these components of blood contain many varying substances. The Serum contains a wide variety of serum proteins. The red cells contain haemoglobins and have blood group substances on their surfaces, and the intermediate Buffy-coat (the white cells) is a valuable material for the study of the tissue antigens.

ANTIGENS AND ANTIBODIES

When blood group substance from one individual is introduced into the blood stream of another, a number of substances called antigens on the surfaces of the red blood cells of the transfusion blood, react with the substances called antibodies in the host blood serum. This reaction is similar to that of blood serum with bacteria which stimulate the production of antibodies, capable of combining with the bacterial substance and hence serving as anti-bacterial agents. Although there are several kinds of interaction all help protect against repeated attacks of the disease, caused by a specific kind of bacteria. The study of such interactions between substances and serum antibodies is called immunology because

+ (118)

Anthropology Paper 01 - Volume 01

in case of the bacteria and the viruses the interaction of the antibodies with bacteria and viruses destroy these organisms, thus affording immunity to disease.

The study of such reactions in humans has permitted the classification of human red cell antigens. These antigens are inherited according to Mendelian principles and the individual keeps the same kind throughout the life. Antibodies however are not usually inherited but are formed in the gamma-globulin molecules of serum exposed to a particular antigen.

POLYMORPHISM

The minor differences in the amino acid sequence of proteins in the blood serum and in enzymes are caused by corresponding differences in the nucleic acids that code for these molecules. Many of the variants are the result of a single variation in the base sequence of the DNA. Some of these variants reach high frequency in some human populations and are called Polymorphisms. A polymorphism may be defined as a gene in which a variant allele has a frequency above 1% in some human populations. There are at least 20 such polymorphic variations in 13 or 14 different human blood group systems, a number of additional polymorphisms among the 23 or so distinguishable serum proteins and at least 4 among the several score of known human haemoglobin variations. There are also normally occurring human variations in the nature of some enzymes. Besides polymorphisms tested in blood, there are a few that affect the substances in the other body fluids, such as one amino acid - in urine and the secretor factor and other components of saliva.

Analysis of the pedigrees of polymorphisms shows whether they are due to allelic or closely linked genes. Those that are allelic or linked constitute a system (e.g., The most familiar system is the ABO system which has four different blood groups A, B, AB, O). There is no evidence of linkage between the different blood group systems and most of them are known to be inherited independently of one another. There are also independent in evolution. Gene frequencies of one system can change while those of another remain the same. Hence two populations may be more similar with respect to one system than another. There are enough mutually independent systems of blood group antigens to permit anthropologists to classify the present day populations into meaningful patterns that reflect historical relationships over centuries. When national or tribal groups are classified according to the frequencies with which they possess the genes for different antigens, fewer and smaller differences are usually found to exist among the neighbouring groups and those with common origins than among groups with widely separated origins.

THE ABO BLOOD GROUPS

Interest in blood groups developed from the practice of transfusion of blood from one person to another. Such experiments began at least as early as the 17th century and were usually uneventful. But in a few instances, the recipient of the blood died following the transfusion. In 1900, Karl Landsteiner, who latter received Nobel prize for this work, discovered why. He noticed that when the red cells from the blood of one individual are introduced into the serum of another, the cells may clump - a reaction called Agglutination.

Landsteiner and his students in 1945 found that they would group the humans into four types on the basis of these reactions. The four types can be explained by the presence or absence of either or both of two substances (the A and B antigens) on the cells. Agglutination was soon associated with the transfusion accidents. For instance, transfusing A type blood into B group patient could produce a severe reaction. The reason why transfusion of blood of the wrong type produce serious and sometimes fatal results is that human blood contains antibodies as well as antigens. The red cells of the donor are agglutinated if the recipient has antibodies to their antigens. Fortunately, blood owners of type 'O' have red cells that are not normally clumped and destroyed by anyone else's serum, so that the blood of group 'O' persons called universal donors can be given in an emergency to individuals of other type.

- The study of ABO blood groups has also contributed to understanding of many genetic principles such as Multiple Allelism, Co-dominance, Polyorphism, Immune reactions & Leakage.

Anthropology Paper 01 - Volume 01

BLOOD GROUP	ANTIGEN	ANTIBODY
A	A	b
B	B	a
AB	A,B	No antibody
O	No antigen	a, b

To study the genetic bases of traits we begin by analysing the phenotype of the trait. Phenotypes can be seen and measured but we cannot directly observe the controlling genes. Once the various phenotypes are known, it is possible to figure out the number of different alleles that are involved in their inheritance by making up a pedigree. A pedigree is an analysis of the phenotypes of related persons.

The A B O blood groups were earliest traits to be analysed by pedigrees. Landsteiner was able to identify the phenotypes A, B, AB and O by observing the pattern of clumping when one person's blood cells were mixed with the serum of another.

Once the Phenotypes were known, scientists worked to determine genes that govern inheritance of different types. Mating between type 'O', type 'A' and type 'B' individuals yielded more children of types A and B than of 'O'. This indicated that the alleles controlling A and B Phenotypes are dominant over the type 'O' allele. Since children of parent of type A and parent of type B showed AB phenotypes, it was assumed that both A and B alleles are dominant. Ultimately the existence of three alleles A, B and O was proposed to account to the known phenotypes. There were thus six possible genotypes - AA, AO, BO, BB, AB and OO. But there only four phenotypes because 'O' is recessive to both A and B alleles, so that AO and BO are expressed as A and B phenotypes.

GENOTYPE	PHENOTYPE
AA	A
AO	A
BB	B
BO	B
AB	AB
OO	O

The world distribution of A B O blood group frequencies is now better known than that of any other human polymorphism. In general the gene for the blood group 'O' is at a minimum in the centre of the European, Asian and African landmass and reaches its highest frequency among the American-Indians. The gene for the blood group A also tends to be somewhat peripheral in distribution, whereas a gene for group B is centrally distributed although not predominant in any population. Among Australian aborigines, the B gene is found only in the North where it may have been introduced from New Guinea or elsewhere. The B gene probably did not occur in the New World prior to Columbus. Formerly it was assumed that the distribution of ABO blood group genes nearly reflected the movements and mixtures of peoples with different gene frequencies. It now seems more reasonable that different ratios of these genes occur under different conditions. For example, the relatively high ratios of the gene for blood group B may occur in the areas of urban civilization due to some advantages of its possessors in resistance to epidemic diseases such as Plague and small pox, which spread among densely settled populations.

Blood group B is very much prevalent in Asiatic people with a maximum concentration in the central Asian countries among the mongoloids (35 - 37%). The frequency of this blood group decreases as we proceed Westwards, where it shows a 25% concentration in Egypt, 22% in Ukraine, 15% in Europe and shows a very less concentration of about 2% in American population and is completely absent in North and South American Indians.

(B group decreases & A increases as we proceed Westwards from Pacific Coast of Asia) to the Atlantic Coast of Europe

- Distribution of blood groups in India:

- B - Freq. is higher than in other Countries ; Ranges from 6% in Nagas of Andaman to 9% in Bihar
- A - High freq. in West and Eastern Himalayas & in Mizoram & Manipur
- O - Low presence
- Rh - Freq. of allele d (Rh-) is high among Mundari group

Anthropology Paper 01 - Volume 01

~~Ex. 2~~ Blood group A has the highest frequency in central and Western Europe, with 45% itself in England. ~~high freq. of 'A' group are found in some Australian Aboriginal pop.~~

~~Ex. 3~~ Blood group 'O' is prevalent in North and South American populations where it reaches a rate of 96% in the former. In the world statistics, blood group 'O' is common followed by blood group A which is trailed by blood group B.

MNS SYSTEM

Karl Landsteiner, the discoverer of the blood groups, continued his experiments and in 1927 he and one of his associates, Levine, discovered that when rabbits were injected with human blood, a few of the animals produced antibodies capable of reacting with some but not all human blood specimens. The antigen in the human blood thus identified was designated as M. A second substance N which occurs in some individuals who have M and in all non-M individuals was soon detected by Landsteiner and Levine.

The antigens N and M differ from A and B substances in that the corresponding antibodies are not found in human blood. To test for these human antigens, the antibodies were prepared in the Rabbit. The antibodies to most human antigens are prepared in animals because the antibodies do not occur naturally in human blood. There are two alleles M and N. An individual with an M gene on each of a pair of chromosomes is of type of M; likewise an individual homozygous for N is of type N, but the blood of heterozygous individuals reacts with both kinds of antisera and they are of type of MN. There is thus no Mendelian dominance and the alleles M and N are expressed equally and are codominant. The MN system gene frequencies like those of ABO system vary throughout the world suggesting that different genotypes are advantageous under different conditions.

More recently, two additional antisera anti-S and anti-s have been prepared. One or the other or both of these react with all blood specimens. S and s are closely related to M and N because the frequency of S is not the same in individuals of type M, MN and N. The system may therefore be referred to as the MNSs or simply the MNS system.

GENOTYPE	PHENOTYPE
MMSS	MS
MM斯	MS
MNSS	MNS
MNSs	MNS
MMSS	MS
MMss	Ms
NNss	NS
NNss	Ns
NNSS	NS

MNS?

Rh System → 2nd most significant blood group system in human blood transfusion with around 50 antigen. Most significant antigen is 'D' antigen - coz it's most likely to provoke an immune system. Landsteiner and his associates, especially Philip Levine and A.S. Weiner, continued to make discoveries. In 1939, Levine and R.E. Stetson noted an unusual case of a woman patient whose serum agglutinated (her blood group was of "O") blood of some other group O persons. The following year, Landsteiner and Wiener, injected rabbits with the blood of Rhesus monkeys and found that the resulting anti-rhesus antibodies in the rabbit blood serum agglutinated not only the blood of other monkeys but also that of some humans. It was then shown that the same people react to both kinds of anti-serum, rabbit and human. The antigen they show is designated Rh, because it occurs in the blood of Rhesus monkeys. A series of subtypes of Rh antigen have since been established.

The alleles R and r are respectively necessary for the Rh +ve and Rh -ve individuals. Among the Mongoloids, Rh -ve is very rare and among the whites it is relatively higher.

→ Rh -ve blood types are much less in proportion of African pop (6.3%) than they are in White (15%).

	+	=
O	36.5%	2%
A	22%	0.8%
B	30.9%	1.1%

Anthropology Paper 01 - Volume 01

ADDITIONAL BLOOD TYPES AND THE SECRETOR FACTOR*Not clear!*

Not only there are sub-groups of Rh, but there is at least one important subgroup A2 of A, and there are also several subtypes of M and N. In addition, there are a large number of other antigens that are independent of the previously mentioned systems or related in still unknown ways. These are usually named for the individual in whom the antigen was first found. New types continue to turn up from time to time. They often are discovered when an individual receives repeated transfusions for some diseases and then develops serum antibodies for an antigen of a type he or she lacks but which was in one or more of the transfusions.

The ^{re}secretor factor is also of value in genetic comparison of populations. In some individuals there are substances called secretors. Evidence of their ABO status is found in saliva and in other body fluids. In other persons of the same group the substances are not dissolvable in water and do not occur in the saliva. Besides anti-A and anti-B sera that can be used to test the saliva of A, B and AB individuals, there are anti-H antibodies that react with saliva of some group 'O' individuals. Persons lacking A or B antigens have the corresponding antibodies (anti-A, anti-B) respectively. In the other blood group systems, antibodies are not normally found in individuals who lack the antigen. These other systems therefore have less immediate significance for blood transfusions. Nevertheless, from the anthropological standpoint these factors are equally interested.

Taken in aggregate, the blood groups permit geneticist to plot the frequency distribution of a considerable number of human beings. William C. Boyd, one of the first and strongest advocates of the application of genetic methods to anthropology, has used the distribution of blood group genes to divide the human species into races. Most anthropologists would now prefer to study the various blood group systems in their variations, distributions and changes with reference to ecological settings, disease, and migrations, without invoking any concept of race that applies to overall appearance. Analyses of geographic distribution of blood group are a substitute for and not an adjunct to, racial classification and its interpretation.

THE BLOOD GROUP SYSTEMS IN THE HUMANS

BLOOD GROUP	YEAR OF DISCOVERY	NUMBER OF KNOWN ANTIGENS
ABO	1900	5 or more
MNSs	1927	29
P	1927	3
Rhesus	1940	28 or 30
Lutherian	1945	2 or 3
Kell - Cellano	1946	9
Lewis	1946	3
Duffy	1950	2
Kidd	1951	2
Deigo	1955	1
Auberger	1961	1 or more
X5	1962	1
Sciana	1962	2
Dombrock	1965	1

HAEMOGLOBIN

A molecule of the protein haemoglobin consists of four polypeptide chains, which are normally present in two pairs. Different kinds of such chains exist and each is designated by a Greek letter. Variant haemoglobins are normally assigned English letters. Thus adult normal haemoglobin-A has two alpha and two beta chains. Several other variants are discussed below.

- Gene present on X-chromosome will produce this enzyme

Hb S - is well distributed in Africa because it provides resistance to malaria. It is also found in South India.

Hb C - well distributed in Eastern Africa

Hb E - well distributed in South-East Africa

Anthropology Paper 01 - Volume 01

The haemoglobin molecule consists of four polypeptide chains. There are several kinds of polypeptide chains in haemoglobin. The principle kind of adult haemoglobin is haemoglobin A (HbA). The foetal haemoglobin is represented as HbF. The HbA has a mutant form HbS, found in the persons suffering from Sickle-celled anaemia. Another polymorphic form of haemoglobin, HbC is also found which differs from the normal HbA, in its amino acid sequence. HbE is another polymorphic form of haemoglobin formed due to the mutation in HbA. HbC and HbE are related to a malarial parasite affecting those different from HbA and HbS.

~~G6PD~~ A blood protein called Glucose-6-Phosphate dehydrogenase is found in the RBC. Certain populations show the deficiency of this enzyme. They are found in Africa, Asia, Indonesian Islands, Burma and India etc. The distribution of this enzyme in the populations is correlated with the infection by a malarial parasite Plasmodium falciparum. The deficiency of this enzyme has a sex-linked inheritance. The G-6-PD deficiency is found in people whose ancestors have lived in the areas of the world with a high incidence of Malaria. Individuals who inherit the deficiency are better equipped than non-deficient persons, to resist malarial infections.

+ Pg-18

only
pg-183

RACIAL CRITERIA, RACIAL TRAITS IN RELATION TO HEREDITY AND ENVIRONMENT

People owe their differences to genetic and environmental factors. Both these interact so that the degree of manifestation of genetic factors depends on the environment. To a greater extent such interaction has played an important role in producing differences between people which, in turn has allowed human life to exist in a wide range of environments than would have been possible without this variety. The question of significance of the persistence of this variety has been much debated. Explanations have been put forth in reference to natural selection which ensures that the members of the species conform to the best type. However, the complexity of environments and relation to organisms are of paramount importance which has ultimately resulted into polymorphic states.

As a gene may influence many characters and a character may be influenced by many genes, the facts of heredity are very complicated. Man is a world-wide species. The original roots of racial diversity must have been partly in the production of types suited to particular conditions. However, man has tended to maintain and magnify, for many reasons, superficial differences in features. For example, skin colour is believed to reflect racial differences. Human communities remain distinct partly because they contain individuals whose genes endow them with different physical capacities. The pattern of human life is not based upon communities composed of identical individuals. In fact we have varied capacities, motivations, satisfactions and hence opinions.

Since man has been able to control the conditions around him, the question of what constitutes his 'environment' assumes a new aspect. The extremes of some climatic conditions may stimulate the inhabitants to find ways to isolate themselves from heat or cold. Living in centrally heated and air conditioned buildings has its own hazards for pharynx and respiratory system. This may set up selection pressures which are slightly different than others who are subjected to the normal hazards of climate. Infectious disease constitutes another environmental factor. Naturally, there are differences between people in the pattern of their resistance to infection. Thus, environment constitutes a very wide range which refers to the sum total of social, economic, moral, intellectual and all other patterns of learned behaviour which influence the genes along with the behaviour pattern of human beings. This however is always coupled with all the external physical forces that affect the life of an organism.

Both genetic and environmental factors influence most of our characteristics. Some categories can be recognised which include elements of both heredity and environment. These may broadly be categorised as (i) differences due to accident, (ii) differences due to adaptive response during the lifetime of the individual, and (iii) differences due to cultural influences.

Generally, people differ in power of their adaptation because of differences in the degree of the hereditary control which is not easily altered by environment. On the other hand, there are characteristics like those

- ✓ Miscegenation refers to interracial marriage, intra-racial sexual relations and more generally to the process of racial admixture that took place since ancient history.
- ✓ Africa has a long history of interracial mixing with Arabs & Europeans as a result of slave trade (Ex: Mulatto pops of Africa)
- Chinese + African ; Indian + African ; Americans + African

Anthropology Paper-01 - Volume 01

of brain which are subject to hereditary influences but greatly affected by the environment. The endocrine system, muscles or blood are intermediate between these extremes. Thus there are some features having greater while others having lesser capacity to adapt during development. These powers of adaptation are inherited which help in responding various organs to environmental influences.

Human differences may arise due to accident. Some people are born a little wiser than others. Similarly children born to mothers who are affected by German measles during the early months of pregnancy suffer from serious defects in the heart, brain, bones and elsewhere. The features also differ in their susceptibility to such afflictions. The complication of pregnancy leads to a variety of clinical conditions 'ranging' from cerebral palsy through epilepsy, mental deficiency, behaviour disturbances and reading disturbances.

People depend on the environment for food, water, air, warmth and many other factors. They are greatly influenced by the climate. It is suggested that there is a high incidence of congenital malformations in areas containing igneous rocks with a relatively high radioactivity.

The relationship of climate and disease is a specially interesting and important area. Diseases due to prevalence of parasites and intermediate hosts in certain areas are major problem of homeostasis e.g., the prevalence of malaria, hookworms, yellow fever, dysentery, sleeping sickness and other tropical conditions. Resistance to all these depend to a large extent upon hereditary factors and on the capacity to survive with parasites or worms. Naturally we depend on the special conditions and many organs of the body including brain enable an individual to tolerate his diseased condition. Selection certainly operates and that is why people inhabiting tropical countries differ from those of temperate zones (those zones are devoid of intermediate hosts and hence the diseases mentioned above are not prevalent). Some of the differences between humans are undoubtedly due to the fact that survival depends largely on the capacity to resist infection. Sickle cell gene provides the best example where change of one amino acid in the haemoglobin reduces its value as an oxygen carrier. This is fatal when the individual is homozygous. However, in heterozygous condition it confers some protection against the malarial parasite. Possibly there are variations in the capacity to resist all infective diseases (by production of anti-bodies). Resistance to infection by diphtheria bacilli is partly the result of the presence of a hereditary factor. Similarly the familiar distribution of Poliomyelitis suggests the involvement of hereditary factors. Very little is known about the capacity to resist even the more ordinary infections.

In addition to the above, every habitat imposes a particular climatic regime on man which varies widely and especially so because man can make appropriate adjustments with his habitat. Human body is sensitive to many ailments that go to make up a climate of the place. This sensitivity and responsiveness help to maintain homeostasis. Under the conditions of extreme heat or cold, the heat regulatory system acts to maintain the body temperature within certain limits. At high altitudes it is the respiratory system which keeps the pressure of oxygen and carbon dioxide of the body fluids adjusted within stable limits. In addition to the stresses imposed by thermal factors and the low barometric pressure (at high altitudes) other environmental hazards are provided by excess of short wave radiation including both ultraviolet light and ionizing radiations. The efficient adaptation of human body to climatic change is necessary for the attainment of bodily comfort, performance of physical work without undue fatigue, performance of skilled work involving alertness and dexterity and attainment of normal growth and development.

As regards response to heat, the total number of sweat glands varies in different individuals, though striking differences between different racial groups do not seem to exist. In an investigation by Weiner, South African Bantus and Europeans were found to have very similar sweat gland count. In Europeans the density of glands has a distribution in decreasing order as follows: it is maximum in the upper limb (dorsum of hand > fore arm > upper arm), followed by the lower limb (foot > leg > thigh) and then over the trunk, abdomen and thorax. In Indians and Africans, the gradients are similar.

The complex changes that make up physiological acclimatisation to heat have been demonstrated in peoples of different races living in hot climate (in Nigerians, Chinese, Indians, Malayans living in Malay,

- ✓ - Central Africans are mixed race of people such as Mongols, Turks, Iranians
- ✓ Genetic studies show that Central Asian Turkic people are mixture of North East Asians and Indo-European people (Caucasian ancestry is prevalent in almost all ✓)
- ✓ - Nogais of South Russia - mixture of Mongoloid & Caucasoid
 - Han Chinese + Turkic Uyghur

Anthropology Paper 01 - Volume 01

Kalahari Bushmen, South African Bantus as well as in Europeans in the tropics and in hot deserts). This physiological acclimatisation enables man to carry out his active life under a wide variety of hot conditions and makes it possible for our species to occupy very different kinds of tropical and equatorial habitats. It seems that genetic selection of various bodily characters for life and diverse climate has been superimposed on this physiological plasticity.

There are indications that acclimatisation to cold develops gradually. Increased tolerance to cold can be acquired. The Australian aborigines can sleep naked with little apparent discomfort at air temperatures of about 32°F and radiant temperatures of 50°F. These conditions could not be tolerated and shivering and discomfort were apparent under the same conditions amongst the investigators. Similarly, Bushmen of the Kalahari sleep in extremely cold conditions with only a slight protection of single covering and small fire. A high degree of cold tolerance can be acquired by Europeans and many Norwegians. Eskimos are stated to have a far greater tolerance to cold in the hands than White men. This ability of Eskimos to use the hands efficiently at low temperatures is associated with an increased blood flow. However, the role of thyroid, like the adrenal gland, is involved in cold adjustment. Thus, the available evidence points strongly to the existence of acquired cold tolerance in which physiological adjustments play a large part.

Differences in the average physique of different populations are of significance in climatic adaptations as they conform to the ecological rules of Bergmann (1847) and Allen (1877). According to Bergmann's rule "within the polytypic warm blooded species the body size of a subspecies usually increases with decreasing temperature of its habitat". Allen's rule states that "in warm blooded species there tends to be an increase in the relative size of the protruding organs such as ears and the tail with increasing temperature of the habitat". Several studies have demonstrated that human body size and shape tend to follow these rules. The mean body weight in hot regions is demonstrably lower than that in temperate and cooler climate. Roberts has shown that the lower limbs tend to be longer in hotter climates. The dimensions of the trunk also become less in hotter climates.

The variation in the subcutaneous fat covering in different populations has not been adequately studied. American Negroes have a smaller range of skin fold thickness than American Whites. Possibly Eskimos have thicker fat covering than Negroes.

Owing to the differences in adult physique, growth pattern also shows some relationship to climatic variation. The growth period is prolonged and maturation somewhat delayed in warm periods. A relatively greater height per unit body weight is attained by a delayed skeletal maturation. Coon, Garn and Birdsell have emphasised that Mongoloid face exhibits features adapted to life in extreme cold, e.g., the reduction of brow ridges and the frontal sinuses, flattening and widening of orbital regions to permit more fat padding and the reduction of nasal prominence. Amerindians and Eskimos are not affected by cold in spite of their long periods of exposure to cold. Climatic variables have a high correlation with the shape of the nasal aperture. It has been suggested that the nose shape may be more concerned functionally with moistening the inspired air rather than with heat exchange. Perhaps because of this reason narrow nose is found in both hot and cold deserts (having excessive dryness). The activity of the cilia of the respiratory epithelium is more reduced by drying than by heating or cooling.

The above discussion indicates some functional advantages of certain body characters and their regional occurrence in certain people. It seems that regional selection has proceeded on Darwinian lines and climatic differences may be because of genetic differences. On the basis of twin studies we know that the variations in body shape, size, fat deposition, growth pattern, etc., are all determined largely by the genetic constitution than by purely environmental factors. On the other hand, certain genotypes owing to the multifactor recombination like that of nose shape or limb length and trunk length ratio remain unaffected on change of environment. It has also been suggested that exposure to high temperature during the growth period can result in morphological changes conferring higher resistance to heat stress. This capacity to make immediate responses may have resulted into rapid selection and establishment of appropriate growth patterns in some populations genetically. Each major racial group (Caucasoid, Mongoloid, Negroid or Australia) occupies a wide range of climate possibly because of the physiological

- Macao - Mix of Portuguese & Chinese
- Anglo-Indians - British soldiers + Indians
- India - + Greeks, Scythians, Thracians, Persians, Mongols; Europeans
- In Malaysia, Singapore - Majority inter-ethnic marriages b/w Chinese - Indians = Chindians
- Philippines - Indigenous Negritos + Mainstream Polynesian population.

Anthropology Paper 01 - Volume 01

acclimatisation and partly because of the existence of Bergmann and Allen body size differences and partly to technological adjustment to climatic conditions.

Man's cultural adaptation has provided an additional safeguard. The very spread of man over contrasting habitats would have been impossible if biological adaptation was not supplemented by technological measures. The history of the technology of housing, heating, cooling and clothing suggests that housing demands a high insulation of walls for facing extreme cold demands. Similarly, roof and floor must have been adjusted to make the best use of space in warming appliances and to provide efficient ventilation. The winter habitation of Central Eskimo and those of the Alaska and Greenland display a remarkable mastery of these principles. Man's technological understanding of hot climate had undergone much development by the beginning of the historical period. Humans have developed appropriate building methods to deal with the complex factors of hot, dry or humid conditions. Such methods are always related to physiological principles and standards of comfort and efficiency. Like housing we may examine clothing-including footwear and hand wear - in terms of heat exchange in different climates both hot and cold.

The implications of heredity and environment in the ethnic differentiation of man are not easy to evaluate. However, the nature of the probable mechanism or processes involved in the evolution of ethnic groups of man can be appreciated if we postulate that originally the ancestral human population (which has genetically heterogeneous) inhabited a circumscribed region of the earth. However, gradually individual families or groups of families dispersed over great distances at different times from the original ancestral habitation. Some of these groups became geographically isolated from one another and remained as such for generations. These isolated groups must have been subjected to natural selection, mutation, isolation, genetic drift, hybridisation and social selection. We have already discussed all these factors in detail. However, the implications of natural selection in the context of the interaction of heredity and environment need to be considered again. Natural selection preserves through the action of environment such variations that arise and are beneficial to the organism under its conditions of life (such variations are said to be adaptive). Since natural selection neither has a purposeful design nor foresighted planning, therefore, its results are always relative to the particular environment in which the organisms are living and to their structures and habits. Adaptive traits, therefore, are adaptive only in relation to the environment where structure and function fit harmoniously.

We know that the skin colour is an adaptive character. It has selective value. In human population darkly pigmented people are geographically distributed in high temperature, sunlight and humidity regions while lightly pigmented people are in regions of lower temperature-sunlight-humidity conditions. The marked gradients shown by pigmentation confirm Gloger's rule which states that melanin pigmentation tends to increase in the warm and humid part of the species range. It seems that black pigmentation is certainly promoted by high humidity and high temperature whereas aridity with high temperature promotes the formation of reddish, yellowish and reddish-brown pigment.

Nose is another adaptive character. Thomson and Buxton, on the basis of their research work, have stated that air at higher temperatures is breathed more easily through a broad nose than the narrow one. Because a broad nose allows maximum exhalation of hot air from the lungs, therefore, in hot climates (where heat dissipation is essential!) a broad nose will be at selective advantage. On the other hand, it has been argued that narrow nose represents an adaptation to cold climate where it is necessary that the temperature of the air must be adjusted to the proper warmth and humidity. Kenny has shown that most human desert dwellers have a slender nose which can provide cooling and saturation of the inspired air before its exposure to the respiratory surfaces. Weinger stated that the broad nose is correlated rather more significantly with external absolute humidity than with air temperature and humidity.

It has further been observed that populations living in extremely cold regions, e.g., Arctic area, Siberia, Alaska and Greenland are relatively short and tend to be well padded with fat. Their surface area is less as compared to those who have been living in regions of high temperature. The latter naturally would radiate as much heat as possible while the former as little. Body weight is also correlated with mean.

Mixed races

coloured
EuroAsian
Mestizo
Pardo
Quadrado
Zambo

- (1) C.B. Davenport studied genetic nature of skin colour of Negro-white intermarriages in Bermuda & Jamaica
 (2) Eugene Fischer examined the racial intermixture between European & Negroes in Southern part of Africa.

Anthropology Paper 01 - Volume 01

temperature. Thus the high body weight is associated with high temperatures whereas medium body weight is more temperate regions. Accumulation of fat in cold climate provides insulating qualities which affect body heat loss. A decrease of surface is naturally advantageous in maintaining body heat in the cold environment. A large body size thus serves to reduce heat radiation and a small body size increases it. These facts are in accordance with Bergmann's rule which in this context states that smaller sized members of a population are to be found in the warmer parts of the range and the larger sized members in the cooler areas.

Thus it is clear that the action of natural selection varies under different conditions and the rate at which it operates depends upon the character or quality involved. It may, however, be emphasised that even the organisms possessing certain selective advantages certainly need the cooperation of their fellowmen in order to be preserved. In fact, cooperation is an integral part of the process without which the survival itself would be seriously jeopardised. Thus, it is the cohesive effect of natural selection as represented by the cooperative aspect which ensures the perpetuation of the species or group. The 'Favoured Races' are preserved by cooperation. Cooperation has thus certainly played a role in the evolution of man and also in the interaction of heredity and environment.

RACIAL CLASSIFICATION AND DIFFERENTIATION

One of the most striking features of human species is its awesome variety. In the preceding chapter we have discussed the factors that are responsible for the formation of races. We have noted that races are manifestation of the on-going evolutionary processes and apart from genetic factors, environment, nutrition and culture also play an important role in their formation. We have also seen the various criteria employed by racialists in the classification of human populations. We shall now focus our attention to the different types of racial / ethnic groups in the world, their characteristics and distribution.

History

The first scientific attempt towards classification of the human populations can be credited to the Swedish naturalist Carolus Linnaeus. He has classified our species *Homo sapiens* into four groups

1. *Homo americanus*
2. *Homo europeans*
3. *Homo asiaticus*
4. *Homo afer (Africans)*

In 1775, John Frederick Blumenbach, a German biologist has classified the human populations into five groups or races on the basis of skin color. They are...

1. Caucasian or White: Europeans (except Lapps and Finns). Also found in North Africa, West Asia.
2. Mongolian or Yellow: Includes the Lapplanders and Finns, Eskimos of Americas, Asia
3. Ethiopian or Black: Includes all of Africa except North Africa where Caucasians are present.
4. American or Red: Non Mongolian populations of America
5. Malayan or Brown: All the inhabitants of Pacific.

A number of different classifications have been proposed by different scientists including Pickering in 1848, Topinard in 1885, Quatrefages in 1889 and Deniker in 1889 and many others. For example, Montandon, in 1933 has identified five races of mankind - Pygmy, Veddoid, Negroid, Australoid and

Anthropology Paper 01 - Volume 01

Europoid. In 1925, Ottenberg attempted to classify the races on the basis of ABO blood group system and has identified six races...

1. European: Norwegians, Italians, Germans, English, French, Swedes, Greeks, Anglo-Saxon Americans.
2. Intermediate: Russians, Turks, Arabs, Armenians, Polish Jews.
3. Hunan: Japanese, Southern Chinese, Romanian Jews, Hungarians.
4. Hindu-Manchu: Koreans, Manchu, Northern Chinese, Gypsies, Hindus
5. Afro-Malaysian: Negroes, Malaysians, African Americans.
6. Pacific-Americans: Amerindians, Icelanders, Australian Aborigines.

In 1946 Weiner proposed another classification system based on the frequencies of alleles for ABO system, MNS system, Rh blood factor. His classification identifies six groups of peoples on this basis into Caucasoid, Negroid, Mongoloid, Asiatic, Australian and Amerindian.

In 1931 and subsequently in 1947 Hooton, an American anthropologist have proposed the now widely accepted classification of races into three major groups - Caucasoid, Negroid and Mongoloid - with each one of them further divided into different subtypes.

It is surprising to know that till date more than twenty to thirty different classifications have been given by different scientists at different times. This highlights the lack of agreement amongst them as to what constitutes a race and how many races can be identified in the world. Disagreements exist as different anthropologists use different criteria for classification of races.

We shall now look at the most popular classification of the human races into three races, Caucasoid, Mongoloid and Negroid, with many subtypes. The following table gives a general idea about their racial features.

Trait	Caucasoid	Negroid	Mongoloid
Skin Color	Light reddish white to olive brown.	Brown to brown-black.	Light yellow to yellow-brown.
Hair (Head)	Color: Light blond to dark brown Texture: Fine to medium Form: Straight to wavy	Color: Brown-black Texture: Coarse Form: Curly to wooly	Color: Brown to brown-black Texture: Coarse Form: Straight
Hair on → (Body) Quantity	Moderate to profuse	Slight	Sparse
Eye	Light blue to dark brown in color.	Brown to brown-black in color	Brown to dark brown in color. Presence of epicanthic fold
Head Form	Dolicocephalic to brachycephalic	Predominantly dolicocephalic	Predominantly brachycephalic
Face	Narrow to Medium-broad	Medium-broad to narrow. Presence of prognathism.	Medium-broad to very broad. (High cheek bones)
Nose	Leptorrhine to mesorrhine. High bridge.	Platyrhine. Low bridge.	Mesorrhine to platyrhine. Low to medium bridge.
Stature	Medium to tall	Very short to tall	Medium to short
ABO Blood Group	High incidence of A	High incidence of A and B	High incidence of A
Rh Factor	Highest frequency of Rh -ve	Moderate frequency of Rh -ve	Rare occurrence of Rh -ve

Let us now discuss each of these major races in some detail.

1. CAUCASOID

The Caucasoid include many ethnic groups and racial elements. The following are some of the features of Caucasoid race in general.

1. Skin Color: White, olive, light to dark brown
2. Flat wavy to curly hair
3. Light colored hair with occasional black hair
4. Medium to fine textured hair with rare occurrence of coarse hair
5. Moderate or abundant body and facial hair
6. Doliccephalic to brachycephalic head
7. Leptorrhine to mesorrhine nose; rarely platyrhine
8. High nasal bridge
9. Not so prominent cheek bones
10. Absence of prognathism
11. Thin lips
12. Pronounced or medium chin
13. High forehead
14. Lighter shade of eye color.

The ethnic groups which fall into this category are Mediterranean, Nordic, Alpine, East Baltic, Dinaric, Armenoid, Keltic, Lapp, Indo-Davidian, Polynesian and Ainu.

A. Mediterranean

Though this group derives its name from the fact that they originally inhabited the shores of Mediterranean Sea, today they have migrated to places as far as Asia. They can be seen in Portugal, Italy, France, Greece, Turkey, North Africa, Arabia, Iran, Afghanistan, Pakistan and India.

Sub-Types: There are three sub-types of the Mediterranean group – Ibero-Insular, Littoral and Iranian-Afghan.

The Ibero-Insular sub-type, also called Classic Mediterranean or Basic Mediterranean, are characterized by light brown skin color, wavy or curly black hair, dolicocephalic to mesocephalic head, leptorrhine nose, narrow and oval face with pointed chin, dark eyes and somewhat delicate build bodies of medium stature. They are distributed in the whole of Mediterranean basin including Spain, Portugal, France and Italy. They are also sporadically distributed across eastern, central and north western Europe. This sub-type can also be seen in Egypt, Morocco and other parts of Arabia including Palestine.

The Littoral, also called Atlanto-Mediterranean group is characterized by skins, very wavy to curly hair which is dark in color, dolicocephalic to mesocephalic head, retreating forehead, well developed brow-ridges or supra-orbital ridges, straight nose, long face with slightly prominent cheek bones, usually medium tall stature who are more robustly built than their classic counterparts. They are found amongst

Anthropology Paper 01 - Volume 01

the populations of North Africa, Iraq, Palestine, Eastern Balkans, some parts of Arabia, sparsely scattered in Spain, British Isles and Portugal.

The Irano-Afghan, also called the Indo-Afghan sub-type is characterized by very light brown skin color, black and wavy hair, abundant facial hair, dolicocephalic to mesocephalic head, finely cut, leptorrhine nose with convex bridge, long and narrow face, dark eyes and tall to medium statures. They are distributed across Iraq, Iran, Afghanistan, Pakistan and North-west India.

B. Nordic

The typical representatives of this group are the Scandinavians. People belonging to this group can be seen in Baltic region, Northern Germany, Northern France, parts of Netherlands and Belgium, British Isles and USA.

The main characteristic features of this group are the presence of reddish-white skin, slightly wavy and rarely curly hair with variable hair color including reddish brown, golden brown and ash brown, fine to medium hair texture, sparse or medium body and facial hair, mesocephalic head, usually straight, long and prominent nose, long and narrow face with strongly developed brow ridges, prominent chin, thin or medium lips, blue or grey eyes and tall stature.

C. Alpine

This group is characteristic to populations living in Central Europe, Balkans, Denmark, Norway, North Italy etc. They are sporadically distributed across Europe. Alpine populations are an admixture of Nordic and Mediterranean groups. These people are referred to as the Beaker Folk or Round Barrow Men or Bronze Age Men and are considered a cross between the Nordic and Mediterranean groups.

These groups are characterized by reddish white skin, wavy hair, large, brachycephalic head, well developed brow ridges, flattened occiput, leptorrhine nose, long and narrow face, square chin and large jaw, blue or blue-grey eyes, very tall and muscular and robust bodies

D. East Baltic

East Baltic groups can be found in Baltic States, Russia, North Eastern Germany, Poland, and Finland.

The group is characterized by having a creamy white skin color, light-ash blond or ash brown colored straight hair, medium to coarse texture of hair, moderately developed facial hair with sparsely distributed body hair, brachycephalic head with high and broad forehead, flat occiput, square face with prominent cheekbones, square lower jaws with well developed chin, prominent mesorrhine nose which is convex in profile, low nasal bridge with snubbed tip, light blue or grey eye color and short to medium stature bodies.

E. Dinaric

The Dinaric, also called Adriatic or Illyrian, are distributed across Dinaric Alps region in Yugoslavia, Albania, Austrian Tyrol and sporadically in Central Europe.

These Groups exhibit a combination of racial elements characteristic of Alpine, Nordic, Armenoid and Atlanto-Mediterranean. They are characterized by lighter skin color, straight to wavy hair form which is sometimes curly with medium brown to dark brown color and medium texture; abundant facial and body hair; brachycephalic head, with very high and extremely flat occiput; sloping forehead, well developed brow ridges; leptorrhine nose and a convex nasal profile; fleshy nasal tip; longer and narrower face, heavier and projecting chin; brown or lighter eye color and tall stature bodies.

F. Armenoid

The Armenoids live in Turkey, Palestine and Syria. They can also be found in Iran and Balkan States. These groups are a considerable mix of Classic Mediterranean, Alpine, Nordic and Indo-Afghan racial types.

The phenotypes of this group include olive skin, dark brown to black hair which is wavy or curly in form, with coarse to medium texture; abundant facial and body hair; thick eyebrows; brachycephalic head, high head with vertical occiput and sloping forehead; prominent, leptorrhine nose with high and broad nasal root and convex bridge, fleshy and depressed tip; long and narrow face with well developed cheek bones, medium prominence of chin, moderately prominent lips and medium to tall stature. In these groups the body has a tendency to obesity.

G. Keltic

Keltic groups are distributed in Iceland, Scotland and Wales. They also are sporadically distributed across England and Western parts of Europe.

They are characterized by pale white skin, medium to dark brown skin that can be red; usually wavy or curly and straight hair; mesocephalic head; leptorrhine nose, with a convex profile; long and narrow face and compressed cheek bones; blue or grey colored eyes and tall stature.

H. Lapp

The Lapps are distributed across North Scandinavia, Sweden, Norway, Northern Finland and North West Russia. Some people classify the Lapps with Mongoloid groups.

They are characterized by having graying yellow to yellowish brown skins; dark brown hair which is slightly wavy; sparse body and facial hair; mesorrhine nose with a concave profile and snubbed tip; moderately broad and very short face, moderately prominent cheek bones; narrow forehead and faintly developed brow ridges; occasional presence of epicanthic fold and short stature.

I. Indo Dravidian

They are concentrated in South and Central India. These groups are predominantly Caucasoid and some mixture of Classic Mediterranean and Australoid elements can be seen.

They are characterized by light to dark brown skin; usually black and slightly wavy skin; plentiful hair on the head with medium distribution of facial and body hair; dolicocephalic head; rounded forehead; mesorrhine nose with depressed nasal root and straight profile; narrow and medium length face; moderately developed brow ridges and medium stature.

J. Polynesian

The Polynesian groups live in Polynesian Islands of the Pacific including New Zealand, Samoa, Marquesan and Hawaii. They are a composite race as they are essentially white people with both Mongoloid and Negroid mix.

They are characterized by light brown to yellow brown skin color; dark brown to black hair color which is usually wavy and sometimes straight; sparse body and facial hair; predominantly brachycephalic head with occasional occurrence of dolicocephalic and mesocephalic head; high forehead which is slightly sloping and narrow; flat occiput; prominent nose with slightly depressed root and convex profile; long and broad face with prominent cheek bones; moderately developed brow ridges and well developed chin; lips with medium fullness; medium to dark brown eyes with rare occurrence of mongoloid fold or epicanthic fold; tall stature and muscular body build.

K. Ainu

Ainu's distribution is in Northern Japan, Yezo and South Sakhalin. They represent a very ancient stock of Japan who is predominantly Caucasoid with considerable Mongoloid mix. They resemble the Australian Aborigines in many features.

They are characterized by light brownish white skin; dark brown to black hair which is wavy; abundant hair on the body and face – hence are also sometimes referred to as "Hairy Ainu" mesocephalic head; mesorrhine nose with slightly depressed nasal root and convex profile; short face with medium breadth – mesoprosopic and orthognathus; well developed jaw and chin; thin lips; medium to dark brown eyes which are horizontal and widely opened; occasional epicanthic fold; thickly set bodies with medium or short stature.

2. NEGROID

Some common features of Negroid are

1. Wooly or frizzly hair on the head which is black in color
2. Dark brown to black skin color with yellowish brown in some groups
3. Broad and flat nose with low bridge and root
4. Dark brown to black colored eyes
5. Thick and fleshy lips
6. Small ears with no lobe
7. Marked facial prognathism
8. Predominantly long head with protruding occiput and rounded head profile
9. Small brow ridges

The Negroid are further divided into African Negro and Oceanic Negro.

A. African Negro

This group is further divided into five sub-groups – True Negroes, Nilotic Negroes or Nilotes, Bantu, Bushmen Hottentots and Negrillo.

True Negroes are characterized by dark brown skin color; wooly hair; tall stature, platyrhine nose; dolicocephalic head with bulging forehead and prognathous face; thick lips; short legs and long arms. They are distributed across West Africa and Guinea Coast.

Nilotic Negroes or Nilotes are characterized by very dark skin color, very tall stature, slim figure, long legs; dolicocephalic head; wooly hair; platyrhine nose; less marked facial prognathism and retreating forehead. Some examples of Nilotic Negroes are the Shilluk, Dinka and Kavirondo. They are distributed across Upper Nile Valley and Eastern Sudan.

Bantu are the numerous Bantu speaking people who inhabit Central and Southern Africa. It is not yet clearly ascertained the different ethnic groups who belong to this category. Their characteristic features show a wide range of variation. Their skin color varies from being dark chocolate to yellowish brown and black; hair is Negroid i.e., wooly, typically dolicocephalic head, stature is medium to tall. They possess generally narrower and more prominent nose than the true Negroes.

Bushmen-Hottentots group is composed of both the Bushmen and Hottentots who are physically similar with very little difference in their characters. They only differ from each other in their culture. The

Hottentots are known as Khoi Khoi and the Bushmen as Khuai or San. While the Hottentots are found in South West Africa, the Bushmen are predominantly found in the Kalahari. They are characterized by having short hair on the head which coils up to spiral knots, leaving bare spaces between them - a hair form termed as pepper-corn, hair color is black; sparse facial and body hair; light to brownish yellow skin in Bushmen and light reddish yellow skin in Hottentots; dark brown to black eye color; the Hottentots are slightly taller than the Bushmen with average height of around 4.5 feet. Doliccephalic head amongst the Hottentots and mesocephalic head amongst the Bushmen is seen. Face is shorter, squarer and orthognathus in the Bushmen while it is more elongated, triangular and prognathus in the Hottentots. Prominent cheek bones, small chin, bulbous forehead, little developed brow-ridges; frequently lobeless ears, usually thick lips; platyrhine nose with very broad and flat root, low bridge with concave nasal profile; narrow eyes, slanting with internal epicanthic fold, small hands and feet. One prominent characteristic feature amongst these groups is steatopygia, which is an immense deposit of fat in the buttocks), especially the women of Hottentots.

Negrillo, also called the African Pygmy are very short in stature with an average height of around 4.6 feet. They are characterized by short legs and long arms; steatopygia in the women, mesocephalic head; prognathic face with narrow chin; very flat and broad nose; very short hair on the head which is wooly and dark rusty brown in color and body hair yellowish brown to black. They are represented by the Akka, Ba Twa, Bam Buta and inhabit the equatorial forests of the Congo basin.

Pygmies are found in various regions of the world. Apart from the Congo basin, they are also found in Malay Peninsula, Sumatra, Andaman islands, Philippines, New Guinea etc. They can thus be categorized into African Pygmy, Oceanic Pygmy and Asiatic Pygmy. The last two are also termed the Negritos.

B. Oceanic Negroes

Oceanic negroes include the Negritos - Asiatic and Oceanic and Malenian-Papuan subgroups.

The Negritos are further divided into Andamanese, Semang, Aeta (Asiatic) and Tapiro (Oceanic) groups. The Andamanese inhabit the Andaman Islands of India, Semang in central region of Malay Peninsula and East Sumatra, Aeta are the inhabitants of Philippine Island and the Tapiro live in New Guinea. It is a general belief that all the pygmies of the world are genetically interrelated and they constitute a common pygmy race. However recent researchers have shown that they don't constitute a race as such and the formation of Pygmy is attributed to a large extent to environmental factors. They are characterized by mesocephalic to brachycephalic heads, round faces, short and flattened noses. Skin color is dark chocolate brown and sometimes sooty black. Hair on the head is short and face and body hair is scanty.

Malenian-Papuans inhabit New Guinea, Fiji, Admiralty Island, New Caledonia etc. They are characterized by a typical doliccephalic head with high retreating forehead; heavy and continuous brow ridges and prognathous face. Broad nose, depressed nasal root with convex profile, platyrhine nose in some; usually medium stature; black and wooly hair; abundant facial hair (scanty in some) are other features. Their stature varies from medium to tall with average height of 5.6 feet.

3. MONGOLOID

The following are characteristics of the Mongoloid group...

1. Hair which is black, straight and coarse
2. Yellow or yellow brown skin color
3. Scanty body and facial hair
4. Broad and flat face with prominent cheek bones
5. Obliquely set eyes with narrow slit-like openings with internal epicanthic fold

Anthropology Paper 01 - Volume 01

This group is further sub-divided into four main groups based on their geographical locations - The Classic or Central Mongoloid, The Arctic or Northern Mongoloid or Eskimoids, The Southern or Indo-Malayan Mongoloids and The American Indians.

- Classic or Central Mongoloids are found in Siberia, sporadically in Northern China, Mongolia and Tibet. The representative ethnic groups are Mongoloid tribes like Buriat, Koryak, Goldi, Gilyak and some Tibetans and northern Chinese. They are characterized by brachycephalic head, projecting occiput, rounded forehead, nose with no nasal depression and a very low root, straight to concave nasal profile, strongly developed cheek bones, yellow to yellow brown skin color, hair on the head straight, black and coarse, sparsely distributed facial and body hair, dark brown eyes which are obliquely set with a complete epicanthic fold.
- Arctic or Eskimoid groups are distributed in northern Asia, Arctic coast of North America, Greenland, Labrador and Western Alaska. They are represented by the Eskimo, Chukchi, Kamchatdais, Yakuts, Samoyedes etc. They are characterized by yellowish skin color, straight black hair, large broad and flat face with prominent cheek bones; narrow and prominent nose; remarkably small hands and feet; large trunks and relatively short legs. Eyes are black and often straight; occasional occurrence of a complete epicanthic fold. The Western Eskimos are taller than the Alaskan Estimos. Head form ranges from brachycephalic to mesocephalic.
- Indonesian-Malay Mongoloid are distributed across Southern China, Indo-China, Burma, Thailand, Malay Peninsula, Dutch East Indies, Philippines, Japan and interior of Malay Archipelago. They are characterized by an average stature of around 5.2 feet; brachycephalic to mesocephalic head; mesorrhine to platyrhine nose; straight and black colored hair with occasional reddish tinge; scanty body and facial hair; light yellow brown to dark yellow brown skin; medium to dark brown colored eyes with internal epicanthic fold; short face and prominent cheek bones.
- The American Indian or the Amerindian groups are predominantly mongoloid with some non-mongoloid racial strains like Caucasoid, Australoid and some Negroid elements. They are distributed in different parts of North, Middle and South America. They have black and rarely dark brown hair which is coarse, straight and sometime slightly wavy; scanty distribution of body and facial hair; yellow brown to red brown skin color; dark brown to black eye color; complete mongoloid fold is almost absent; broad face and prominent cheek bones; prominent chin; strongly developed brow ridges; forehead which slopes and face exhibits prognathism. Nose is predominantly mesorrhine and the stature is variable. Head form can either be brachycephalic or mesocephalic.

1) Genetic Markers in Red Blood cells can be discussed under 3 heads

- A) Red Cell Antigens: Blood Group Polymorphisms
- (B) Haemoglobins
- (C) Enzymes

- (A) (i) ABO system (pg-168)
- (ii) MNs system (pg-169)
- (iii) Rh system

- (B) (i) Haemoglobin S (HbS)
- (ii) Malaria & HbS
- (iii) Hb E
- (iv) Hb C
- (v) Thalassemia
- (vi) G6PD

HbA/HbA - normal homozygote
 HbA/HbS - heterozygote
 HbS/HbS - abnormal homozygote
 Heterozygotes are more resistant to malaria in comparison with homozygotes.

2) Genetic Markers in Plasma (Serum Protein)

- (i) Hp
- (ii) Tf
- (iii) Albumin
- (iv) others - Gc, Gm system, Inv system

9.6

ABO, Rh BT Target 9.5

HLA, ~~ABO~~

Gm, Blood enzymes

Respiratory function

Body fat, Transferrin, Hp, Hb level, pulse rate

Sense perception

HbS - Common in African Negroes

HbC, HbE - are variants of sickle cell mutation
and are useful for resisting diff types of malaria
HbE prevalent in SE Asia & India

Genetic Markers

(Xerget material page-88)

Anthropology Paper 01 - Volume 01

9.6 AGE, SEX AND POPULATION VARIATION

In the chapter on Races and Racial Classification we have observed that human populations vary in morphological and genetic characteristics. Apart from this, it has been observed that human populations also vary greatly in physiological characteristics like haemoglobin level, fat level, blood pressure and sense perception. This variation in physiology is not only seen between different populations, but also among the members of the same population. These physiological characters vary so much that they are different in same person during different periods of time. In short, the physiological aspects in man vary depending on age, sex and population.

VARIATION IN HAEMOGLOBIN LEVEL (Janani Suraksha Yojana)

Owen & Pearson The Red Blood Corpuscles (RBC) of blood carries Haemoglobin. Haemoglobin has a complex molecular structure. It is made of a heme group which contains iron and four protein chains.

Metabolic Limit of RBC: The haemoglobin level in a cell fluid is approximately 35 grams per decilitre (gm/dl). The level of Haemoglobin (Hb) never rises above this level. This level is called the metabolic limit of RBC. Maximum concentration is seen in RBC.

Age In 1977, Owen has studied the variation in Hb level according to Age. He, along with Pearson, studied Quebec society in Canada and has indicated that from the age of 20 years to 60 years the level of Hb among the males is maintained at 15.3 gm/dl. The females reach the highest level of Hb, which is 13.5 gm/dl, by the age of 10 - 14. After the age of 14, the boys improve their Hb level by attaining 15.3 gm/dl whereas females more or less remain stagnant. This difference of 2 gm/dl between males and females can be attributed to the menstrual losses among the females. Moreover, there is lesser number of RBCs in a female. For this reason, Allari and Girdwood in 1982 have indicated that an Hb level of 12 gm/dl among males is considered to be a situation of Anemia whereas it is a normal situation among females.

Activity 6 There is a growing interest in ethnographical diversities in Hb level in different populations. It has been observed that there is a relative influence on Hb level by the activity level of the population. Those cultures which demand higher activity from their peoples have selective pressure on higher level of Hb. At the same time, culture and socio-economic statuses also influence Hb level. Since the nutritional levels of people are more often than not cultural adaptations, they significantly influence the Hb level among the people in a population. In most of the ethnic groups, it has been found that there is a gradual increase in Hb level till age of 30. Among the Americans, a constant value is maintained throughout the life and it gradually starts falling only in the old age.

Publication 7 Recent studies conducted in this context indicate that there is a growing secular trend in Hb level. The rise in Hb level in primitive societies is greater than the level prevalent in advanced societies several years ago. This trend is similar in all the ethnic groups.

GLUCOSE 6 PHOSPHATE DEHYDROGENASE - G6PD

TOP 11

1 There are some populations and individuals who show a deficiency of G6PD, which is an enzyme. G6PD deficiency is a heritable disorder. People with this deficiency exhibit a response in their blood called haemolytic response to some drugs and food items like fava or broad beans, which are common foods in the Middle East. If an individual with this deficiency consumes these food items, it may result in a condition called haemolytic anaemia or Favaism. The deficiency of this enzyme results in a condition where the subject's erythrocytes or red blood cells show low levels of reduced glutathione. Glutathione Stability Assay or Test is used to detect people with this problem. G6PD deficiency is an X-linked disorder and is caused by a single gene. Middle Eastern populations exhibit this condition with over 60% of incidence reported among the Kurdish Jews. In Africa, especially the equatorial region, the frequency of this problem is around 10-20% and the trait is also common in some parts of Greece and Iran. Thailand and Micronesian populations also exhibit this trait with incidence rates of around 10%.

2 G6PD is a blood protein found in RBC
3 This enzyme is necessary for carrying normal life of RBC

G.S. Kartic (karticsg@gmail.com)

183

4 Distribution of this enzyme is correlated with infection of malarial parasite (P.F.)

5 Individual who has this trait are better equipped

Join US ! Telegram : <https://t.me/nailedupsexam>

protein in blood serum, a β globulin that transports iron from sites of red-cell destruction and from intestine to the bone marrow where Hb is synthesised

Anthropology Paper 01 - Volume 01

TRANSFERRINS → About 20 inherited variants are found

Transferrins are beta globulin factors present in the serum of blood and they are capable of binding the ferric ions in the blood tissue. They are also called Siderophilins. Normal individuals exhibit the presence of only one transferring band denoted by TfC. However, amongst some other groups, especially the Australian Aborigines, there is an extra band of transferring TfD. Transferrin is determined by a single gene. A third variant of transferring is also reported amongst some East Asian populations and Lapps and this variant is represented as Dem. Usually, transferrin polymorphism is determined by many alleles at a single locus in an individual's genome.

HAPTOGLOBINS (Hyp) → is a protein in blood serum which combines with haemoglobin in plasma & helps in transferring free haemoglobin to the liver where Hb is broken down for production of bile salt (biliverdin). Hb-Hyp complex is broken by electrophoresis.

There are two globulins that are capable of binding free haemoglobin that has escaped from the RBCs. This binding is crucial as it prevents haemoglobin from damaging the kidneys by passing through glomeruli.

The haptoglobins are found in the blood serum and can be separated by electrophoresis. In 1955, Smithies recognized that the patterns of haptoglobins are not same in all individuals and there are three types - Type 1-1, 2-2 and 2-1. Family studies have indicated that the above patterns are inherited and possibly more than one allele is involved. These alleles (recognized later to be two) are named Hyp¹ and Hyp².

Population studies indicate that the frequency of Hyp¹ gene is around 40% in Western Europe. Its incidence is much higher in tropical Africa. It has lower values in South Africa (30%). In Asia, its frequency is much lower - about 10%. The selective forces at work are not clearly known. In some infections and inflammatory diseases, higher levels of haptoglobins are found. Ex: Hyp¹ - Malaria.

VARIATION IN BODY FAT 34 weeks ↑ Birth ↑ 9 months ↓ 8 yrs ↑ puberty → Adolescence

1 There is a unique distribution of fat, especially subcutaneous fat over the body. Heredity and environment have a significant role to play in establishing the fat level of the person.

2 Subcutaneous fat layer has age related changes. Fat begins to be laid in the fetus at about 34 weeks and increases from then on until birth and until nine months after the birth.

3 When the child is attaining prepubescent height, i.e., from 9 months to 8 years, the fat level shows negative velocity. This decrease in the fat level is due to the breakdown of fat by the growth hormone. This fact is also supported in cases where a deficiency of growth hormone brings about an increase in fat level. The fat content present around bones and muscles decrease with increase in their size. The fat level of the body also shows sex related variations. While both boys and girls show reduction in fat level till the age of 8 years, the decrease in girls is comparatively slow.

4 An increase in the fat level of the body marks the period from 8 years to puberty, in both the sexes. It is only at adolescence that a temporary halt in increasing fat level is seen among the boys and this loss of fat is gained back after 20 years. This temporary halting among the boys is seen in trunk and limbs while there is no such loss among the girls.

5 The nutrition level and the level of activity are other facts with a socio-economic dimension which control fat level. Increase in nutrition and decrease in activity level increases the fat level of the body. This is the reason why in industrial societies fat related disorders are very common. Genetics also control the fat level deposition to an extent.

6 In some ethnic groups, there is an increased deposition of fat in thighs and buttocks, a condition called steatopygia which occurs in Bushmen and Hottentots populations.

PULSE RATE

Pulse is the number of heart beats per minute. The pulse is measured at the wrist, neck, temple, groin, behind the knees, or on top of the foot. In these areas, an artery passes close to the skin. Measuring the pulse can give very important information about the health of a person. Any deviation from normal heart rate can indicate a medical condition. Fast pulse may signal the presence of an infection or dehydration. In emergency situations, the pulse rate can help determine if the patient's heart is pumping.

Sex variation in Pulse rate?
other variations

Anthropology Paper 01 - Volume 01

The pulse measurement has other uses as well. During exercise or immediately after exercise, the pulse rate can give information about the fitness level and the health of a person.

Pulse rate varies according to the age of persons, whether they exercise or not and other physiological conditions in the body.

For resting heart rate:

- newborn infants; 100 to 160 beats per minute
- children 1 to 10 years; 70 to 120 beats per minute
- children over 10 and adults; 60 to 100 beats per minute
- well-trained athletes; 40 to 60 beats per minute

Resting heart rates that are consistently high (tachycardia) and resting heart rates that are below the normal values (bradycardia) may indicate a problem.

Changes in the oxygen pressure, high altitude areas and other metabolic demands on the body may also cause change in the pulse rates.

VARIATION IN BLOOD PRESSURE (Boyce, Attenborough, Harrison)

(Not in syllabus directly)

The blood pumped by heart into blood vessels for its distribution to different parts of the body must leave the heart at some pressure because it has to overcome the resistance offered by frictional and other forces. The pressure at which blood leaves heart is called systolic blood pressure (SBP) and it gives an estimate of contractility of the heart. As heart expands or relaxes, these pressure drops, which give a measure of diastolic blood pressure (DBP). It is at this pressure that heart receives blood. A rise in the SBP indicates increased contraction whereas a rise in the DBP indicates decreased relaxation of the heart, both being harmful if they cross optimum levels. Blood-pressure is indicated in fraction: the upper number indicating SBP and the lower number indicating DBP. Though a pressure of 120/80 is considered an average for the adults, values as low as 115/70 is also considered normal. For the SBP, 100 plus age is also considered normal. Researches show positive correlation between blood-pressure and age, sex, heredity, body composition, and social status.

Knowledge about blood-pressure at the population level is of utmost importance in the assessment of health status, particularly in the detection of cardiovascular diseases. The variations in blood pressure according to age is high during growth and development up to adolescence, thereafter it shows a rhythmic variation on a daily basis. The blood pressure in the neonates during first day averages 70/50. There occurs increase in blood pressure during the next several months to approximately 90/60. The rate of increase is higher during this period. Thereafter, it remains more or less same throughout the adult period.

Using family studies, it has been possible to underline factors for blood pressure variation in a population. It has been estimated that 16% of blood pressure variation is due to environmental factors, 48 percent of additive genetic factors, and 36 percent to dominance. Heredity is indicated in causation of blood-pressure because it has been shown to run in families, though environment seems to be the precipitating agent.

According to Kaplan (1978), the populations can be arranged into three groups on the basis of variation of the blood pressure.

- a) Hypertensive: Systolic blood pressure > 169 mm Hg
 Diastolic blood pressure > 95 mm Hg

People living in high altitude face the problem of low $O_2\%$. To compensate more RBCs are produced. Vital capacity of lungs is 4-5 litres. This capacity varies according to Age, sex, size of the individual; Race also.

Males = height \times 20 ml Europeans have higher vital capacity - males = $h \times 25$ ml
 Females = height \times 16 ml Females = $h \times 20$ ml

- This capacity diminished with age.

Anthropology Paper 01 - Volume 01

b) Borderline cases: S.B.P. 140 - 160 mm Hg

D.B.P. 90 - 95 mm Hg

c) Normotensives: S.B.P. < 140 mm Hg

D.B.P. < 90 mm Hg

+ (Starting page)

In a majority of rural Indian population the percentages of the normotensives have been almost always found to be more than 95%. In many cases, percentage of normotensives and hypertensives has been found to be higher than borderline. This indicates that in majority of the populations persons either are normotensives or hypertensives. The cardiovascular system perhaps has the ability because of homeostatic mechanisms, to sustain changes due to stress and strain of environment. This seems to have a threshold limit. Once it is crossed, there is no scope of return and a normotensive becomes hypertensive. This may be reason for low percentage of borderlines compared to hypertensive patients.

On the contrary, studies conducted indicate that in industrialised population the proportion of normotensives in comparison to hypertensives is not so high. Hypertensives are around 5% subjects showing increase in both SBP and DBP. Another feature of the industrialised society is a small but significant group of borderlines. This is probably because the homeostatic mechanisms are disturbed in such societies due to nutritional and life style reasons. Among the nutritional reasons, absence of green vegetables and fruits and inclusion of fat to a great extent in the diet have been the most glaring reasons for the increase in percentage of border-line cases and hypertensive.

In cases of both rural and urban populations, it has been found that the variations of the blood pressure tend to be lower in the household samples than that of hospital. It is probably due to natural settings of the house, free from anxiety and tension. Blood pressure, as it is a multifactorial condition, may tend to recover in situations of normal, tension-free emotions.

Scientists associated with such population studies of blood pressure variation outside India are Boyce Attenborough, Harrison - Thornabrook and Sinneff. The group has been involved in recording population variation in blood pressure since 1970. They have analysed populations of New Guinea etc. and have reached to the same conclusions that in addition to heredity, diet and stress and strain of life are the two most important causative environmental factors of high blood-pressure.

VARIATION IN SENSE PERCEPTION

Using family studies it has been possible to describe factors for BP variation in a population. 16% of BP variation is due to environmental factors; 48% additive genetic factors; 36% dominance.

There have been some population studies of physiological variations that include survey of different sensory mechanisms. Among the various sensory mechanisms, the most thoroughly surveyed are ability to taste phenylthiocarbamide and red and green colour-blindness. The ability to taste PTC is an autosomal polymorphic trait (Vogel and Motulsky). Tasters with genotypes TT, Tt have the ability to taste the substance while non tasters are homozygous for the recessive allele 't'.

The defective colour vision has long been used as a genetic marker in the study of human variation. Red-green colour blindness is an X-linked trait in which individuals fail to distinguish red and green from other colours. Various populations inside and outside our country have been surveyed like Turkey, Balkans, Nigeria, Myanmar, etc. In India, such studies have mainly been conducted in South India.

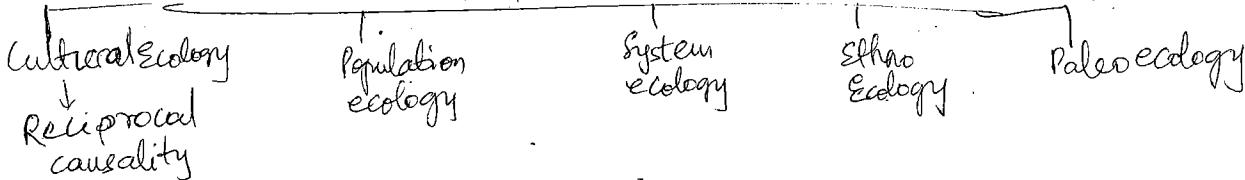
Most of the studies related to PTC tasting have found sex-differences in the trait: females are found to be more sensitive to the taste of PTC than males and the difference is statistically significant in Balkan, Burmese and Nigerian population. Though females are more sensitive than males, the difference does not appear to be significant one. Muslims of India also do not show sex differences in ability to PTC tasting.

5 types of sensory receptors:

- ① Mechanoreceptor - Pressure, touch, sound
- ② Photoreceptor - Light
- ③ Phonoreceptor - Sound

④ Tangoreceptor - Gustatory receptor - Taste

⑤ Olfactory receptor - Smell



9.7 CONCEPTS AND METHODS OF ECOLOGICAL ANTHROPOLOGY

CONCEPT OF ECOLOGICAL ANTHROPOLOGY

Every organism, human and non-human, responds to structural and functional characteristics of their environment. Adaptations result from exposure to physical and chemical factors in the environment, from interaction with other species and from the interaction of individuals within the same species. Evolutionary change through the mechanism of natural selection involves the replacement of individuals with one type of adaptation by those with another. This adaptation involves a slow adjustment to environmental change and is studied at both the individual level as well as at the population level.

1 Ecological anthropology ^{deals with} concentrates on the mechanisms of human adaptability. It is unique in its way because it integrates the findings from ecology, physiology, social and cultural anthropology and geography around the set of problems set or posed by the human habitats. This problem oriented approach lends itself to the integration of data and at the same time orients the researcher toward answering the question, how do humans adapt?

The answer to this question is found through the study of human adaptability, which emphasizes the human response to environment. This adaptability is manifested in both socio-cultural and physiological terms. Socio-cultural responses such as clothing, shelter and various forms of social organization help to articulate the adjustment of our species to the environment. Physiological changes require changes in organic structure and function and therefore take longer to come into operation than socio-cultural responses. Both types of responses provide a more rapid mechanism for improving survival chances than the genetic change, which accumulates over several generations. Hence a need arises where so much varying facts which are both biological and socio-cultural, need to be integrated in order to understand the concept of human adaptability. This is exactly what ecological anthropology does. It integrates the facts regarding human physiology, geography, genetics, society and culture in order to throw invaluable light on the way in which human species try to maintain equilibrium with the environment by adapting to it. Ecological anthropology tries to explore the multilevel ways in which humans adjust to their surrounding by both biological and non-biological processes.

The interaction of the social and biological approaches to the study of adaptability was facilitated by the increasing acceptance of the ecosystem concept. This concept, derived from the study of biological ecology concept, views all organisms as part of ecological systems and subject to the same physical laws. Using this framework, one can refer to human beings as the third order consumers in the food chain or view the interaction between two human populations as mutualistic. The ecosystem concept makes it possible to apply a greater body of data to explanatory models of human behavior than is possible from strictly social or cultural approach. Ecological anthropology recognizes this fact.

METHODS OF ECOLOGICAL ANTHROPOLOGY

A major influence on ecological anthropology came from general or biological ecology. Ecological study in its broadest sense, applies to the dynamic relation between living and nonliving parts of an ecological system. The ecosystem concept provided a conceptual framework more satisfactory to some scientists than the behaviour/social structure equation stressed by Steward. By studying human population as parts of ecosystems, attention can be paid to human adaptability - physiological, cultural and behavioural.

The research strategy of ecological anthropology is to study a wide range of human responses to environmental problems, to social constraints, and to past solutions of environmental problems. Little and Morren have succinctly expressed the strategy as "ecological anthropologists are concerned with those cultural and biological responses, factors, processes and cycles that affect or are directly connected with the survival, reproduction, development, longevity or spatial positions of people".

An ecosystem includes all the organisms in a given area, interacting with the physical environment, so that a flow of energy leads to a clearly defined trophic structure, biotic and material cycles. Ecosystems are

Anthropology Paper 01 - Volume 01

said to be self-maintained and self-regulating. The concept of homeostasis, which in the past has been defined as the tendency for biological systems to resist change and to remain in a state of equilibrium, has led to an overemphasis on static considerations and to an evaluation of man's role as basically disruptive. Recently certain scholars have defined homeostasis as the maintenance of system properties.

The ecosystem quality leads naturally to use the systems analysis techniques. Systems analysis has become a useful approach for anthropologists since it begins with a holistic model of components and interrelations of an ecosystem, essentially a qualitative and descriptive process with which anthropologists feel at ease. Systems theory provides a broad framework for analyzing empirical reality and for cutting across disciplinary boundaries. Essentially, systems theory is a perspective that bears a great deal of similarity to anthropological holism; a system is an integral whole and no part can be understood apart from the entire system.

Clifford Geertz was perhaps the first anthropologist to argue for the ecosystem as a viable unit of analysis in cultural anthropology. In taking a whole systems approach, Geertz notes that historical and political factors must also be included, if one is to explain, say, agricultural development.

Roy Rappaport and Andrew Vayda have given the strongest impetus to an ecosystem approach in the field of cultural anthropology. In fact, they prefer the term ecological anthropology because they feel that the emphasis on culture suggested by the term cultural ecology obscures the applicability of principles from biological ecology to the study of human adaptation. Given that humans are but one species in nature, subject to the same laws as other species, use of the principles, methods and analytical tools of the ecological sciences would greatly add to our understanding of our own species. Vayda and Rappaport believe that anthropologists should not hesitate to adopt biological units as units of study since this allows a more comprehensive approach to ecological studies. Ecologists have shared various areas of interest with anthropology; ways of defining territorial rights, ways of establishing group identity and mechanisms for establishing buffer zones. All these can be viewed ecologically as regulating behaviour or serving a homeostasis function.

Bennett criticized the use of biological analogies, but concedes that Rappaport's study is important as a concrete demonstration of the fact that the behaviour of men toward each other, as well as toward nature, is part of ecosystems. Bennett finds the distinction between cultural ecology and the ecosystems approach artificial. The choice of one approach over the other depends on the size and complexity of the group under study. Among small tribes with primitive technologies, the ecosystem approach can be employed since much of the human environment interactions in such tribes are embedded in cultural traditions. On the other hand, in larger, complex and technologically advanced cultures, institutions and technology have created a distance between the population and its environment. Studies of modern societies must investigate these institutions and the processes of decisions that affect nature and humans. In these contexts, Bennett argues the ecosystem approach does not work well because it cannot research the dynamic processes of institutions and the conscious processes of choice among alternatives due to the complexity of the systems.

Homeostasis and dynamic equilibrium do not imply changelessness. On the contrary they require constant adjustment of system parts and even some change in structure. In other words, while systems have lower order mechanisms geared at the maintenance of stability, they also have higher level, less specialized mechanisms that can reorder the system to assure its survival.

So far the studies with ecological anthropological approach have concentrated on isolated populations of Alaskan Eskimos, South American Yanomamo Indians, New Guinea tribesmen, and Miskito Indians of Central America. The choice of such small isolated groups was made because it permitted easier monitoring of the interaction between the human population and their environment. Monitoring the complex relationships between such environmental stresses as disease, low energy and food availability, heat, cold and altitude in technologically complex societies would be far more difficult task. It is likely that once a clearer understanding of the human ecology of simpler cultures has been reached, ecological

anthropologists will be able to more easily study human response to environmental degradation, urban pollution and other contemporary stresses.

The Geographers consistently show a greater sophistication in their analyses of the physical environment, while anthropologists deal with cultural components of the analyses with greater insight and facility. Although anthropologists have no difficulty dealing with the micro scale, since it has been their traditional unit of research, there is concern over the applicability of these micro studies to the large context of human behaviour and human adaptation.

It is certainly premature to expect the ecosystem perspective to resolve most of our questions about how humans adapt. Close cooperation will be required between biological and behavioural scientists to generate an integrated study of people in ecosystems. In the future, studies are likely to be most fruitful when they integrate the general systems approach with the study of how actors develop their own individual strategies. There is no reason why both perspectives cannot be used, and there is evidence that researchers have already begun to balance a concern for the individual with a concern for the population. One way to overcome the tendency towards static equilibrium models might be to study how populations adapt to certain kinds of stress. By studying the response of individuals to hazards, we can answer such questions as, does stress lead to changes in the structuring of the population? Are cultural patterns changed? How do people perceive the severity of the stress to which they are responding? How does the human population adjust to termination of the stress? These questions are more likely to be productive in outlining systemic interrelations in populations experiencing changing situations than in those with stable situations. This however presents even greater challenges to researchers. As a way of dealing with these challenges, Allard has proposed what he calls structural ecology, which integrates cognitive / structural and bio ecological aspects of human adaptation.

THE ETHNO-ECOLOGICAL APPROACH

A very different approach to the study of human environment relations grew out of developments in the field of sociolinguistics. This general approach has been termed ethnoscience and deals with the study of various cultural perceptions of the world and how people order those perceptions through their given language. Ethnoscience has given rise to subfields dealing with specific domains of culture, such as ethnobotany, ethnozoology, and ethnoecology. The aim of ethnoecological approach is to provide a better understanding of how people perceive their environment and how they organize these perceptions.

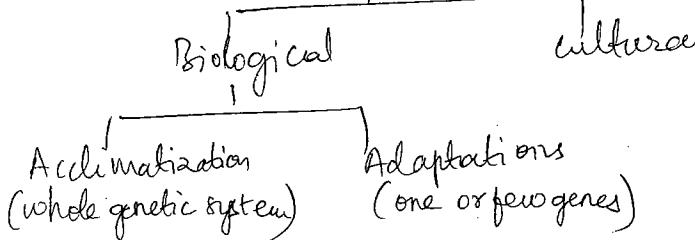
BIO-CULTURAL ADAPTATIONS – GENETIC AND NON GENETIC FACTORS

What is Ecology?

- Ecology is the study of organisms in relation to the surroundings in which they live. These surroundings are called the environment of the organism. This environment is made up of many different components, including other living organisms and their effects, and purely physical features such as climate and soil type.

Ecologists, those who study ecology, are always aiming to understand how an organism fits into its environment. The environment is of supreme importance to an organism and its ability to exist in the environment where it lives will determine its success or failure as an individual.

Thus ecology deals with the problem of how growing and multiplying beings maintain themselves in a constantly changing but, ever restricted environment. It proceeds, in other words, with the conception of life as a continuous struggle for adjustment of organisms to environment, a struggle initiated and continued essentially by the differential modes of change of these two components of the life process. In the ecological view, life is not an individual but, an aggregate phenomenon. Hence the underlying assumption of ecology is that adjustment to environment is a mutual, in fact a communal function. The adjustment of a population to its physical world occurs not through the independent actions of many



individuals but through the coordination and organization of individual actions to form a single functional unit.

Human Ecology

Human ecology, as plant and animal ecology, represents a special application of the general viewpoint to a particular class of living things. It involves both recognition of the fundamental unity of animate nature and awareness that there is differentiation within that unity. Man not only occupies a niche in nature's web of life, he also develops among his fellows an elaborate community of relations comparable in many important respects to the more inclusive biotic community. In at least one of its aspects the human community is an organization of organisms adjusted or in process of adjustment to a given unit of territory. Hence the rise of human ecology has meant a logical extension of the system of thought and the techniques of investigation developed in the study of the collective life of lower organisms to the study of man. Human ecology may be defined as the study of the form and the development of the community in human population.

Ecology as applied to man differs in important respects from its application to other forms of life or even to life as a whole. Man is an organism, to be sure, and as such he has much in common with other forms of organic life. But at the same time, he is capable of an extraordinary degree of extensive control over his surroundings, as manifested in the degree to which he modifies and reconstructs his environment through invention and the use of tools, and again in the complex cooperative arrangements entered into with his fellow men. Furthermore, man's great faculty for devising and accumulating methods of coping with life situations is evidence of dynamics in human behaviour that is without counterpart elsewhere in the animate world. It is this that constitutes man as an object of special inquiry and makes possible a human ecology as distinct from a general ecology.

It is necessary to keep the phenomenon of human culture in proper perspective. When man by nature of his culture-producing capacity, is regarded as an entirely unique type of organism the distinction has reached a point of overemphasis. Human behaviour, in all its complexity, is but a further manifestation of the tremendous potential for adjustment inherent in organic life. Thus, if we look upon culture as a totality of the habitual ways of acting that are general in a population and are transmitted from one generation to the next, there exists for human ecology no peculiar problems other than those involved in the fact of its complexity. The term simply denotes the prevailing techniques of adjustment by which a population maintains itself in its habitat. The elements of human culture are therefore identical in principle with the appetency of the bee for honey, the nest building activities of birds, and the hunting habits of carnivores.

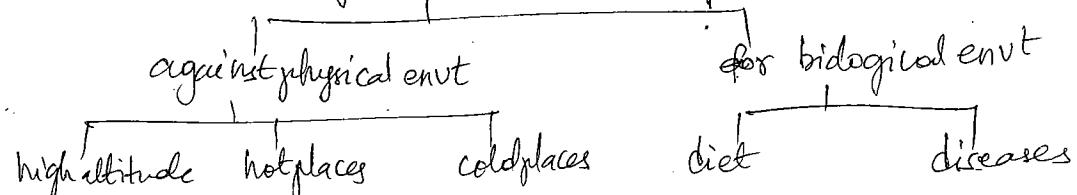
ADAPTABILITY, ADJUSTMENT AND ACCLIMATISATION

Adaptation - pg - 187 (points 1-5)

The term "adaptation" is at the heart of ecological approach. Organisms, human and non-human, respond to structural and functional characteristics of their environment. Adaptations result from exposure to physical and chemical factors in the environment, from interaction with other species, and from the interaction of individuals within the same species. Evolutionary change through the mechanisms of natural selection involves the replacement of individuals with one type of adaptation by those with another. This type of evolutionary or genetic adaptation involves a slow adjustment to environmental change and is studied at level of population.

Individuals, however, can respond to changes in their environment by morphological and functional adjustments. Ricklefs differentiates between regulatory, acclimatory and developmental adjustments. All three types operate by a process known as negative feedback. This type of feedback seeks to maintain a stable relationship between the organism and the surroundings. To be effective, a response must be of the proper magnitude and occur at a time and rate that is appropriate in relation to the stimulus that elicited the adjustment.

Adjustments
 Regulatory (Acclimation)
 Acclimatisation
 Developmental



Anthropology Paper 01 - Volume 01

→ (Acclimation)

Regulatory Responses: These occur rapidly and reflect the physiological and behavioural flexibility of an organism. Virtually all behaviour is a form of regulatory response that either serves to maintain a stable relationship to the environment or permits adjustment to changes in that environment. Cultural strategies of clothing and shelter are among the most common regulatory mechanisms that enhance human chances to survive and live in relative comfort in a variety of environments.

Acclimatory Responses: These take longer to come into operation because they require a change in organismic structure. They occur when an external stimulus is present for a sufficient amount of time. They are usually reversible when the situation that produced the organismic change ends. For example, muscle enlargement as a result of frequent and demanding physical exercise is reversed when the individual begins to lead a more sedentary life.

Developmental Responses: These are not reversible and occur during the growth and development of an individual. They are adjustments of the organism to the environmental conditions prevalent during the developmental period. During this developmental period human organisms have the ability to mold themselves to prevalent environmental conditions - genetic plasticity. For example, a child growing at high altitudes will develop larger lungs and chest capacity to adjust to prevalent low oxygen conditions. After the growth period, a non-native will be unable to achieve a larger chest cavity. Developmental adjustments are of limited value for short term environmental adjustments, but provide a more flexible adjustment to prevalent conditions than the genetic change. The developmental flexibility of the human population provides a more rapid mechanism for improving survival chances and enhancing reproduction than genetic change accumulated over several generations.

The ecosystem is a fundamental ecological unit that refers to associated species of living organisms in a nonliving physical environment and to the structural and functional relationships among them. In the study of human adaptability, the ecosystem is the total situation within which adaptability occurs. Because human populations have spread over the totality of the earth, this context of adaptability varies a great deal. A population in a specific ecosystem adjusts to environmental conditions in specific ways that represent both present and past conditions. In other words, a desert population that has existed in that environment for several millennia will differ significantly in its responses to desert conditions than a population that migrated there only in the last generation. A population that has existed longer in a particular environment is more likely than a recently settled population to have developed physiological and even genetic characteristics aimed at coping with environmental constraints, such as extreme heat. The more recent inhabitants will have physiological and cultural adjustments attuned to another environment. When they begin adjusting to the new environment, a process of change will be initiated that may take several generations, and the final result may or may not be much like the adjustments of the original inhabitants. This is particularly true when native populations are available from whom to borrow a variety of forms of adjustment. The newcomers may borrow some of the practices of the original inhabitants in order to achieve a satisfactory adjustment to their new habitat.

Adaptability!

The above scenario suggests that human adaptability can proceed along any one of many paths. In the absence of borrowing and diffusion of ideas, the population may innovate and develop new forms of adjustment. If the new adjustment pattern conflicts with the previous practices and yet provides a workable solution that does not threaten the survival and well-being of the individual or group, some form of compromise may emerge. If the exposure to stress is continual, physiological change of a permanent kind (development adjustment) may provide a more adequate adjustment than regulatory forms. The human body is able to adapt by genetic, physiological and behavioural and cultural means. The purpose of these various levels of adjustment is to enhance adaptability through a flexible hierarchy of response.

3 Human adaptability, therefore, refers to ecological success as measured by demographic, energetic or nutritional criteria. Demographic criteria often used are: (1) balance between natality and mortality, (2) morbidity or incidence of disease and (3) the population's rate of reproduction. Energetic criteria can be relative or absolute. Relative energetic efficiency is used as an indication of the adequacy of a technology.

Anthropology Paper 01 - Volume 01

Efficient subsistent technologies have been noted to be sustainable at low levels of population density. In the past it has been more common to use total energy harnessed as indicative of success. Nutritional criteria provide a good index of adaptability since food consumption reflects knowledge of resources, capability to exploit them and capacity to achieve given level of work capacity.

However, all these criteria are only indices of adaptability and do not constitute any firm measure of fitness. Fitness refers to reproductive success. The more "adapted" a species is in its environment, the greater the opportunity for individuals of the population to survive and reproduce and then to occupy the territory. It is much easier to define energetic failure or inefficiency and nutritional inadequacy than to determine reproductive success. The problem of over population raises numerous questions about the adequacy of fitness as an index of human adaptability.

MAN'S PHYSIOLOGICAL RESPONSES TO ENVIRONMENTAL STRESSES

HOT DESERTS

(P.NATH - Graphs)

- 1 ✓ Arid lands, or deserts, are characterized by low and random distribution of rainfall, high levels of solar radiation, high daytime temperatures, high levels of evapotranspiration, and a consequent scarcity of plant cover during most of the year.
- 2 (a) Human populations appear to have neither genetic nor developmental adaptations for living in dry heat areas. They depend instead on acclimatory and behavioural adjustments to facilitate their occupation of these regions. Acclimatization to desert conditions actually occurs within a week or two. However, it is the problems of locating water, storing it, and minimizing its loss that is central to human adaptation to arid conditions.

Desert Ecosystems: Deserts are not homogeneous, but vary a great deal in characteristics. Generally speaking, they can be said to be areas of very low rainfall and high evaporation where vegetation is scanty. Not only is the precipitation low, it is infrequent and largely erratic as well. True or extreme deserts are said to be those with less than 100 mm of rainfall. They lie beyond the equatorial rainfall belt and in latitudes where drying trade winds blow throughout the year. Deserts may also appear in areas dominated by the subtropical high pressure belt, on the leeward side of high mountains where moisture-laden air is blocked from crossing; in areas far removed from sources of oceanic moisture; and in locations on the leeward side of cold currents. Winds that pass over cold water reach land with lowered temperatures, but are warmed as they pass over the land and act as drying agents when they pass over moist land. Each type of desert is characterized by unique variations in daytime temperatures, level and seasonal distribution of rainfall and vegetation.

Deserts can be areas of surprising contrasts. In daytime, temperatures may rise to 43°C., while at night they may drop to an uncomfortable zero degree temperatures. Surface heating is rapid, but cooling is just as rapid when the sun sets because of high albedo (that is surface reflectivity) and clear skies. Weathering is slow and absence of vegetative cover makes every detail visible. Large and small closed basins dramatically cut by surface runoff and erosion is common.

Adjustment to Dry Heat: Before a human population can exploit the resources of a desert, its individual members must be able to cope with the hot and drying stresses of the ecosystem on their organisms. An individual in the desert is constantly threatened with dehydration and physiologically dangerous heat loads. Thermal sweating helps reduce heat gain through evaporation of moisture at the skin surface. When air and ground temperature are below 33.3 °C., human beings lose heat by radiation to cooler ground or by convection to cooler air. In the desert, however, daytime temperatures are often higher and sweating is the only effective mechanism. To become cool, we pay with loss of body water. The human body appears dry in the desert because evaporation is so rapid that as sweat nears the surface, it disappears (insensible evaporation). No changes in the human metabolism are needed to maintain this cooling system, but one must obtain an equal amount of liquid to replace what is lost.

Case Studies - Heat adaptation

9. ① Joel Hanna ② Daniel Brown } gave comparison of Sahara, Kalahari & Arabian deserts & how people are used to stay.

Anthropology Paper 01 - Volume 01

Water requirements cannot be represented by an absolute figure, but are a function of ambient temperature, air humidity, diet, and level of activity. A body at rest that is protected from the sun requires at least five ounces of water per hour to remain in body fluid equilibrium. Less water intake means the body would utilize stores of tissue liquid, eventually resulting in dehydration and thermostatic deregulation. Exposure to solar radiation adds to his equilibrium requirement an extra sixteen ounces per hour; and walking an additional twelve ounces per hour. Water requirements increase proportionately according to increase in activity level and temperatures. Reduction of activity and adoption of a relaxed posture that increases surface area help compensate for increases in heat load in the human body.

Physiological Adjustments: To date, physiological studies tend to agree that human populations acclimatize to desert conditions within a week or two. Very little difference in heat adaptation has been noted between desert natives and non natives. A diminished pulse rate, lower rectal temperatures, increases in the rate of sweating and ability to work in the heat are remarkably similar among human populations. Acclimatized individuals show a reduction in the salt concentration of sweat, which prevents deficiencies associated with cardiovascular inadequacy and violent muscular cramps. Urine volume is also reduced as a homeostatic compensation for increased dehydration. These few factors represent the bulk of physiological changes that occur. Adolph has raised questions about the limitations of the desert ecosystem on the amount of physical work that could be achieved, but concluded that these limitations are not severe as long as people have enough water. Further work is needed to establish whether alleged limitations on the amount of work that is possible to achieve might not be associated with work schedules that are inappropriate to desert living.

4. Body size, shape, and composition can also influence the heat exchange process. The "ideal" body type for desert conditions is tall, with long, lean extremities and low subcutaneous fat. Tallness maximizes the surface area to weight ratio for enhanced cooling, while lean body composition minimizes the presence of insulating fat that may limit heat flow from core to shell to cool the body. The Nilotc peoples of Sudan are often cited as an example of optimal human form for desert environments. However, one could also argue that such greater surface area would also maximize evaporation of sweat and expose those individuals to dehydration unless factors intervened to ameliorate that possibility. In fact, social and cultural patterns enter in to provide exactly such protection.

While there is some positive correlation between ideal body types and different body temperatures, factors such as migration, nutrition, and disease preclude a perfect association between body shape and environment. In desert areas today we find peoples of all shapes, sizes and degrees of leanness. The major adjustments of human mammals are not small size and nocturnal habits, nor complex physiological adjustments as among camels; they are cultural and behavioural in nature. The problem of how to cope with aridity may be overcome by activity patterns, clothing, shelter, diet and other similar adjustments.

Summary: To survive in any ecosystem, populations must take into account the existing constraints to life. In arid lands the challenge to human inhabitants lies in determining how much control to exercise over water resources and how to make optimal use of the water obtained. Most commonly, groups have scattered widely over these areas, thus keeping the densities per unit areas down. Kalahari hunter gatherers even today maintain effective population controls through dietary, social and cultural adjustments. Nomadic way of life, activity schedules designed to avoid exposure to strong sun etc.

Cyclical changes in aridity necessitate flexible form of social organization, a nomadic way of life, or modifications in the technology of water use. We can expect that when severe drought strikes in frequent cycles, the population will adjust their lifestyles to the driest periods of the cycle. This has been clearly the case among the populations of the Kalahari. When the driest episodes are infrequent or unpredictable, however, populations will adjust to normal years and experience serious stress during dry periods.

8. These adjustments to the requirements of the thermoregulatory system prevent dehydration, heat stroke & possible death.

9.

Individual survival must also be assured by behaviours that conserve water and at the same time permit constant cooling evaporation through effective sweating. Acclimatory adjustments through diminished pulse rates, reduced salt concentration in sweat, and intensified rates of insensible perspiration increase comfort. Most of the adjustments, however, are social and cultural. Clothing and shelter reduce the heat load of the body by providing insulation and promoting heat loss. Activity schedules are designed to avoid exposure to strong sun and drying winds and at the same time conserve energy and fluids. These adjustments to the requirements of the thermoregulatory system prevent dehydration, heat stroke and possible death.

~~Applinks x~~ COLD, HIGH ALTITUDE CLIMATES (Carlos Monge's hypothesis) + Notes (pg-22)

Mountain Ecosystems: Since the prehistoric times, human populations have occupied high altitude zones despite the numerous problems initially encountered by persons entering such areas. Anyone who has grown and developed at sea level will, when first exposed to high altitudes, experience symptomatic discomfort, reduced work capacity, accelerated breathing, higher haemoglobin levels, and higher arterial pressure. It is not surprising to find relatively small numbers of peoples living at high altitudes. Some ten to twenty five million people, i.e., less than one percent of the earth's population, currently make it their home. The majority of the areas occupied are within forty degrees of the equator where solar insolation is greater and, all things being equal, biotic productivity is higher. These areas include the South American Andes, the mountains of Ethiopia, the Caucasus of southern Russia, the Asian Himalayas, and the Rocky mountains of the United States.

High altitudes have been the subject of intensive research in human biology and ecology. In most other biomes, cultural practices can play a major buffering action, but in the high altitude biome, hypoxia (low oxygen pressure) provides one of the few situations in which behavioural, regulatory adjustments play a secondary role to acclimatory and developmental adjustments. Human biologists saw in these regions an ideal setting to study potential genetic and physiological adaptations. These studies were stimulated by the important writings of Carlos Monge who postulated that Andean natives were biologically different from, and possessed adaptive characteristics not found among, lowlanders. Since that time numerous workers have sought to test the validity of Monge's hypotheses.

A) Adaptation to Hypoxia

1 ✓ Hypoxia, or low oxygen pressure, is the most important stress with which populations living at high altitude must cope. Cultural practices are not able to increase the amount of oxygen available to human subjects, but some of its associated problems have been minimized through appropriate diets, work patterns, and cultural attitudes towards reproduction. It was thought at one time that populations native to a high altitude had genetic adaptations that permitted them to reproduce and live with no apparent difficulty where outsiders experienced serious malfunctioning. It now appears that there is no direct evidence of population-level adaptation to hypoxia in man, but only indirect evidence, based on inferences from individual and infra individual adaptations. Human adaptations to hypoxia appear to reflect the general genetic plasticity common to all of mankind, rather than distinctive genetic attributes.

2 ✓ The partial pressure of oxygen decreases with increasing altitude. Hypoxia results whenever either physiological, pathological, or environmental conditions cannot deliver an adequate supply of oxygen to the tissues. Since air is compressible, air at high altitudes is less concentrated and under less pressure. At 4500 meters the partial pressure of oxygen is decreased by as much as 40 percent, in comparison to pressure at sea level. This reduces the amount of oxygen finally available to the tissues.

3 ✓ Adaptations to high altitude hypoxia results in a series of modifications in body functioning that are oriented toward increasing the supply of oxygen. Because some of the adjustments to hypoxia are developmental, it is not surprising to find different adaptive mechanisms in sea level and highland populations. Sea level or lowland populations utilize the less efficient response of increased pulmonary ventilation, in contrast to the developmentally acquired advantage of increased lung volume, to achieve the same adaptive result.

- ① Cynthia Beall - Tibetan, Andean, East African Highlanders
② Vikas Tripathy - Tibetan Refugees in India.

Anthropology Paper 01 - Volume 01

The adaptive responses to hypoxia are directed toward increasing both the availability of oxygen and the pressure of oxygen at the tissue level. Some of the physiological mechanisms that facilitate adaptation to hypoxia operate along the oxygen pressure gradient in the body and permit oxygen to reach tissues despite the low atmospheric pressure. Other mechanisms operate at the level of the tissues and include enlargement of the capillary bed.

At high altitudes oxygen pressure can be 40 percent or more below sea level pressure. Without adaptive mechanisms, the tissues of a man living at 4,000 and above meters would have an oxygen tension inadequate to diffuse oxygen and make it available for cell metabolism. At high altitude, where that pressure is already low to start with, the organism adjusts by shortening the distance the oxygen must travel. This is accomplished by an increase in the number of capillaries. (Enlargement of capillary bed).

An increase in the pulmonary ventilation is a common response to high altitude. Natives have a moderately higher breathing rate, i.e., 20 to 40 percent, than sea level populations, and newcomers to high altitudes will quickly begin to hyperventilate (breathe rapidly). Highland natives have a larger lung volume and greater residual lung volume (that is, the volume of air that remains in the lungs after maximum expiration). This increased volume is a developmental adjustment accomplished by the proliferation of alveolar units and an increase in alveolar surface area during childhood.

Polycythemia refers to an increase in the number of red blood cells and in the amounts of haemoglobin in persons acclimatized to high altitude. It does not appear to be present in uterine life, but develops rapidly within a few days after birth. Prolonged exposure to hypoxia has a stimulating effect on bone marrow growth. As a result, more red blood cells are produced and there is an increase in the total volume of red blood cells in the body (i.e., the thickening of the blood). Associated with the increased production of cells, there is a decrease in blood plasma so that blood contains a larger volume of red blood cells and haemoglobin. This means that a greater quantity of oxygen can now be carried which helps reduce the oxygen gradient between arterial and venous blood and aids the buffer capacity of blood for carbon dioxide.

Work Capacity and Diet: Accounts of the great physical capacity of natives at high altitudes are somewhat exaggerated. Although there is little doubt that natives perform better than newcomers at high altitudes, carefully designed experiments have not shown any significant superiority in natives when they move to lowland areas. Good physical training and lifelong exposure to high altitude act to increase maximal oxygen consumption. Grover finds the Andean native physiologically similar to the athlete; both share a high aerobic or maximal work capacity. The native accomplishes this by exposure to atmospheric hypoxia and an active life, and the athlete by subjecting himself to strenuous exercise that subjects the muscles to tissue hypoxia.

Childhood development at high altitude, on the other hand, enhances adult work capacity. There might be a genetic factor involved to their lower body weight, their vigorous life in the pursuit of subsistence, and their characteristic high carbohydrate diet. It has been shown that a high carbohydrate diet enhances endurance of hard work through increase of muscle glycogen.

Body tissues require a constant dietary supply of carbohydrate to provide energy. Absorption of ingested carbohydrate in the intestine is dependent on the time the carbohydrate is in contact with the absorbing surface, and on the supply of enzymes for the oxidation of carbohydrate. Once oxidized, carbohydrate is absorbed into the bloodstream as glucose, galactose and fructose. The last two are later transformed to glucose in the liver. Glucose is stored as glycogen for storage and is reconverted to glucose when needed by body.

Low levels of glucose and problems of carbohydrate mal absorption are apparently widespread health problems in highland natives. It is not clear; however, to what extent the general reduction in food utilization is a result of hypoxia.

Ex: High altitude Training Institute - Min of Defense/Space affairs

Anthropology Paper 01 - Volume 01

Growth rate

Reproduction, and Maturation: Hypoxia appears to affect reproduction. It was found that moderately high altitudes where most Andean populations live have only a mild effect on reproductive performance. A more dramatic effect on reproduction is reflected in lower birth weights and increased postnatal mortality. Although short term difficulties in spermatogenesis and menstruation are experienced upon moves to high altitudes, men and women native to the area appear normal in these respects.

There appears to be no hypoxia stress on the fetus during pregnancy, possibly as a result of an increase in the size of the placenta. There is also a decrease in the birth weight relative to the placenta, which facilitates delivery of oxygen to the fetus without unduly increasing the demands on the mother.

In addition to the birth weight being low, the growth rate and development of children at high altitude is slow. This may be related to the demands of chest and bone marrow development during growth. During childhood important changes occur in alveolar area and diffusion capacity that facilitate the diffusion of oxygen. Maturation is delayed at high altitude, and sexual dimorphism (the differentiation between males and females as manifested in body size and muscle size) appears to occur only after the sixteenth year.

Maladaptations: Not all individuals native to high altitude adapt to hypoxia, and some lose their adaptation. This is known as chronic mountain sickness and involves loss of normal stimulation of breathing. This leads to low oxygen pressure in the alveoli and in arterial blood. To compensate, the body experiences excessive Polycythemia (that is, the thickening of blood). The only cure involves bleeding the person every two or three weeks, but the best solution is to leave the high altitude zone. Since high altitude natives also sometimes engage in seasonal migration to lowlands, they may also experience pulmonary edema on returning to altitude (that is, build-up of fluid in the lungs which interferes with the transfer of oxygen from the air to the bloodstream). Following several weeks at sea level, even natives may experience this temporary illness upon return to high altitudes.

(B) Cold Stress (Only Target Notes - pg - 23)

Next to hypoxia, cold is the most significant stress felt by high altitude populations. However, it is more amenable to management than hypoxia by appropriate cultural practices.

Long term exposure to cold stress may lead to acclimatization. The responses of the habituated demonstrate an increased peripheral blood flow to the extremities that prevents cold injury, limits heat loss through the hand, and permits easier hand functioning in cold conditions.

Such a difference in response to cold appears to be developmental. Studies of foot exposure to cold air at 0°C in the Andean highlands showed that both native adults and children maintain warmer skin temperatures than whites, but the differences between the young and the adult studied suggest that this ability increases through the developmental period. If this is the case, the neonate may experience unusually severe cold stress. Researchers have found that brown adipose tissue (BAT) is present in human infants and plays important roles in maintaining high core temperatures and in promoting non-shivering thermogenesis. Normal fat as a percentage of the body weight is at its lowest at birth. Between birth and age one, however, it increases six fold, while the stores of brown adipose tissue are slowly depleted.

Summary: Human adaptation to high altitude zones involves a combination of behavioural and physiological adaptations that have made it possible for populations to survive in this vertically zoned environment. The major constraint is hypoxia and numerous developmental adaptations are particularly valuable. An enlarged capillary bed, Polycythemia, decreased alveolar arterial oxygen gradient, and other mechanisms are involved in facilitating survival in an oxygen scarce environment.

Basic statistical tools of epidemiology

- (a) Mortality rate - (Total deaths)
- (b) Incidence rate - (New cases)
- (c) Prevalence rate - (Total cases)

9.8 EPIDEMIOLOGICAL ANTHROPOLOGY

Sub discipline of Medical Anthropology

Epidemiology deals with study of incidence, distribution, control of disease in a population

CONCEPT OF EPIDEMIOLOGICAL ANTHROPOLOGY

- Over the past two decades increasing interest has emerged in the contributions that social sciences like anthropology might make to epidemiological study of health and disease. There are several reasons for this increasing interest. Primary among these has been the rise of chronic, non-infectious diseases as important causes of morbidity and mortality among westernized societies during the 20th century. Generally speaking, the chronic, non-infectious diseases are influenced by a number of lifestyle variables, which are themselves strongly influenced by social and cultural factors. The understanding of the effects of behavioral factors, thus require an understanding of the social and cultural forces on different conditions of health and disease. Equally, there is a growing awareness that considerations of human behavior and its social and cultural determinants are important for understanding the distribution and control of infectious diseases. Related to this expansion of the epidemiological interest in the behavioral realm has been the development of etiological models which focus on the psychological, biological and socio-cultural characteristics of hosts, rather than exclusive concern with exposure to a particular agent.
- Both epidemiology and anthropology have undergone parallel evolution. Epidemiologists have been forced to define and measure complex social and cultural processes hypothesized to have an impact on health and disease states. Anthropologists, on the other hand, have become increasingly interested in the potential contributions of their discipline to resolve the day to day problems of specific populations, and especially so within the realms of disease occurrence and health care. These convergent interests have created the opportunity for mutually beneficial cross-disciplinary study - Epidemiological Anthropology.

- As epidemiology has expanded its concerns to encompass the full range of human disease and disorder, researchers have been forced to grapple with complex assemblages of psychological, social, cultural, demographic and genetic factors in their quest to identify etiologic relationships and improve health services. The recognition that causal assemblages often include phenomena as acculturation, anomie, ethnicity, and poverty has led epidemiologists to look to anthropology in explaining the relationship of social and cultural processes to health. The interdisciplinary research in epidemiological anthropology has revealed that any human disease or disorder is the result of many factors within what may be described as a "causal web", a web of determinants. These webs, their extent varying between populations depending on their size and density, include...

- Exogenous Factors - Biotic and Non-Biotic
- Endogenous (Genetic) Factors
- Demographic Factors
- Behavior, as governed by social, cultural and psychological factors

- It is the goal of epidemiological anthropology to identify and measure the relative importance of factors within the causal web of disease. Since almost all the diseases are caused, at least in part, by behavior of individuals, epidemiological anthropology must be a behavioral science. Epidemiological anthropology, as a specialization within the parent discipline of medical anthropology, grew essentially with these concerns.

HEALTH AND DISEASE

Health Def

- Health could be defined theoretically in terms of certain measured values; for example, a person having normal body temperature, pulse and breathing rates, blood pressure, height, weight, acuity of vision, sensitivity of hearing, and other normal measurable characteristics might be termed healthy. Biological criteria of normality are based on statistical concepts.

- ↳ Is disease a value-free or value-laden notion?
 - A natural (or) normative one?
 - For ex:- should alcoholism be classified as a disease & how should alcoholics be treated by the society.
 - Suppose if it is accepted as a disease, then the concept is strongly value-laden
- (AIDS patient - children - treated as untouchables)

Anthropology Paper 01 - Volume 01

Health Def 2

- ✓ Health might be defined better as the ability to function effectively in complete harmony with one's environment. Implied in such a definition is the capability of meeting—physically, emotionally, and mentally—the ordinary stresses of life. In this definition health is interpreted in terms of the individual's environment. Health involves more than physical fitness, since it also implies mental and emotional well-being.

The definitions of illness and disease are equally difficult problems. Despite the fact that these terms are often used interchangeably, illness is not to be equated with disease. A person may have a disease for many years without even being aware of its presence. Although diseased, this person is not ill. Similarly, a person with diabetes who has received adequate insulin treatment is not ill. An individual who has cancer is often totally unaware of having the disorder and is not ill until after many years of growth of the tumour, during which time it has caused no symptoms. The term illness implies discomfort or inability to function optimally. Hence it is a subjective state of lack of well-being produced by disease. Regrettably, many diseases escape detection and possible cure because they remain symptomless for long years before they produce discomfort or impair function.

Disease Def 1

- ✓ Disease, which can be defined at the simplest level as any deviation from normal form and function, may either be associated with illness or be latent. In the latter circumstance, the disease will either become apparent at some later time or will render the individual more susceptible to illness. The person who fractures an ankle has an injury—a disease—producing immediate illness. Both form and function have been impaired. The illness occurred at the instant of the development of the injury or disease. The child who is infected with measles, on the other hand, does not become ill until approximately 10 days after exposure (the incubation period). During this incubation period the child is not ill but has a viral infectious disease that is incubating and will soon produce discomfort and illness.

Disease Def 2

Disease, defined as any deviation from normal form and function, may be trivial if the deviation is minimal. A minor skin infection might be considered trivial, for example. On the eyelid, however, such an infection could produce considerable discomfort or illness. Any departure from the state of health, then, is a disease, whether health is measured in the theoretical terms of normal measured values or in the more pragmatic terms of ability to function effectively in harmony with one's environment.

- ✓ Disease may be acute, chronic, malignant, or benign. Of these terms, chronic and acute have to do with the duration of a disease, malignant and benign with its potentiality for causing death.

An acute disease process usually begins abruptly and is over soon. Acute appendicitis, for example, is characterized by the sudden onset of nausea, vomiting, and pain usually localized in the lower right side of the abdomen. It usually requires immediate surgical treatment. The term chronic refers to a process that often begins very gradually and then persists over a long period. For example, ulcerative colitis—an inflammatory condition of unknown cause that is limited to the colon—is a chronic disease. Its peak incidence is early in the second decade of life. The disease is characterized by relapsing attacks of bloody diarrhea that persist for weeks to months. These attacks alternate with asymptomatic periods that can last from weeks to years.

The terms benign and malignant, most often used to describe tumours, can be used in a more general sense. Benign diseases are generally without complications, and a good prognosis (outcome) is usual. A wart on the skin is a benign tumour caused by a virus; it produces no illness and usually disappears spontaneously if given enough time (often many years). Malignancy implies a process that, if left alone, will result in fatal illness. Cancer is the general term for all malignant tumours.

- ✓ Diseases usually are indicated by signs and symptoms. A sign is defined as an objective manifestation of disease that can be determined by a physician; a symptom is subjective evidence of disease reported by the patient. Each disease entity has a constellation of signs and symptoms more or less uniquely its own; individual signs such as fever, however, may be found in a great number of diseases.

Classifications of diseases

✓ Classifications of diseases become extremely important in the compilation of statistics on causes of illness (morbidity) and causes of death (mortality). It is obviously important to know what kinds of illness and disease are prevalent in an area and how these prevalence rates vary with time. Classifying diseases made it apparent, for example, that the frequency of lung cancer was entering a period of alarming increase in the mid-20th century. Once a rare form of cancer, it had become the single most important form of cancer in males. With this knowledge a search was instituted for possible causes of this increased prevalence. It was concluded that the occurrence of lung cancer was closely associated with cigarette smoking. Classification of disease had helped to ferret out an important, frequently causal, relationship.

The most widely used classifications of disease are (1) topographic, by bodily region or system, (2) anatomic, by organ or tissue, (3) physiological, by function or effect, (4) pathological, by the nature of the disease process, (5) etiologic (causal), (6) juristic, by speed of advent of death, (7) epidemiological, and (8) statistical. Any single disease may fall within several of these classifications.

In the **topographic classification**, diseases are subdivided into such categories as gastrointestinal disease, vascular disease, abdominal disease, and chest disease. Various specializations within medicine follow such topographic or systemic divisions, so that there are physicians who are essentially vascular surgeons, for example, or clinicians who are specialized in gastrointestinal disease. Similarly, some physicians have become specialized in chest disease and concentrate principally on diseases of the heart and lungs.

In the **anatomic classification**, disease is categorized by the specific organ or tissue affected; hence, heart disease, liver disease, and lung disease. Medical specialties such as cardiology are restricted to diseases of a single organ, in this case the heart. Such a classification has its greatest use in identifying the various kinds of disease that affect a particular organ.

The **physiological classification** of disease is based on the underlying functional derangement produced by a specific disorder. Included in this classification are such designations as respiratory and metabolic disease. Respiratory diseases are those that interfere with the intake and expulsion of air and the exchange of oxygen for carbon dioxide in the lungs. Metabolic diseases are those in which disturbances of the body's chemical processes are a basic feature. Diabetes and gout are examples.

The **pathological classification** of disease considers the nature of the disease process. Neoplastic and inflammatory disease are examples. Neoplastic disease includes the whole range of tumours, particularly cancers, and their effect on human beings.

The **etiological classification** of disease is based on the cause, when known. This classification is particularly important and useful in the consideration of biotic disease. On this basis disease might be classified as staphylococcal or fungal, to cite only a few instances. It is important to know, for example, what kinds of disease staphylococci produce in human beings. It is well known that they cause skin infections and pneumonia, but it is also important to note how often they cause meningitis, abscesses in the liver, and kidney infections. The sexually transmitted diseases syphilis and gonorrhea are further examples of diseases classified by etiology.

The **epidemiological classification** of disease deals with the incidence, distribution, and control of disorders in a population. Epidemiology is one of the important sciences in the study of nutritional and biotic diseases around the world. The United Nations supports, in part, the World Health Organization, whose chief function is the worldwide investigation of the distribution of disease. In the course of this investigation, many observations have been made that help to explain the cause and provide approaches to the control of many diseases.

Non-communicable disease → is a medical condition (not) disease which by definition is non-infectious & non-transmittable.

INFECTIOUS AND NON INFECTIOUS DISEASES

GOICE

(I) DISEASES OF GENETIC ORIGIN

- 1 ✓ Certain human diseases result from mutations in the genetic complement (genome) contained in the deoxyribonucleic acid (DNA) of chromosomes. A gene is a discrete linear sequence of nucleotide bases (molecular units) of the DNA that codes for, or directs, the synthesis of a protein, and there may be as many as 100,000 genes in the human genome. Proteins, many of which are enzymes, carry out all cellular functions. Any alteration of the DNA may result in the defective synthesis and subsequent malfunctioning of one or more proteins. If the mutated protein is a key enzyme in normal metabolism, the error may have serious or fatal consequences. More than 5,000 distinct diseases have been ascribed to mutations that result in deficiencies of critical enzymes.
- 2 ✓ Mutations that occur in the DNA of somatic (body) cells cannot be inherited, but they can cause congenital malformations and cancers; however, mutations that occur in germ cells—i.e., the gametes, ova and sperm—are transmitted to offspring and are responsible for inherited diseases. Each gamete contributes one set of chromosomes and therefore one copy (allele) of each gene to the resultant offspring. If a gene bearing a mutation is passed on, it may cause a genetic disorder.
- 3 ✓ Genetic diseases caused by a mutation in one gene are inherited in either dominant or recessive fashion. In dominantly inherited conditions, only one mutant allele, which codes for a defective protein or does not produce a protein at all, is necessary for the disorder to occur. In recessively inherited disorders, two copies of a mutant gene are necessary for the disorder to manifest: if only one copy is inherited, the offspring is not affected, but the trait may continue to be passed on to future offspring. In addition to dominant or recessive transmission, genetic disorders may be inherited in an autosomal or X-linked manner. Autosomal genes are those not located on the sex chromosomes, X and Y; X-linked genes are those located on the X chromosomes that have no complementary genes on the Y chromosome. Females have two copies of the X chromosome, but males have an X and a Y chromosome. Because males have only one copy of the X chromosome, any mutation occurring in a gene on this chromosome will be expressed in male offspring regardless of whether its behaviour is recessive or dominant in females. Autosomal dominant disorders include Huntington's chorea, a degenerative disease of the nervous system that usually does not develop until the carrier is between 30 and 40 years of age. The delayed onset of Huntington's chorea allows this lethal gene to be passed on to offspring. Autosomal recessive diseases are more common and include cystic fibrosis, Tay-Sachs disease, and sickle cell anemia. X-linked dominant disorders are rare, but X-linked recessive diseases are relatively common and include Duchenne's muscular dystrophy and hemophilia A.

Most genetic disorders can be detected at birth because the child is born with characteristic defects. Thus these abnormalities are congenital (existing at birth) genetic disorders. A few genetic defects, such as Huntington's chorea mentioned above, do not become manifest until later in life. Hence it may be said that most but not all genetic diseases are congenital.

- 7 ✓ Conversely, some congenital diseases are not genetic in origin; instead they may arise from some direct injury to the developing fetus. If a woman contracts the viral disease German measles (rubella) during pregnancy, the virus may infect the fetus and alter its normal development, leading to some malformations, principally of the heart. These malformations constitute a congenital disease that is not genetic.

(II)

DISEASES OF IMMUNE ORIGIN

The immune system protects against infectious disease, but it may also at times cause disease. Disorders of the immune system fall into two broad categories: (1) those that arise when some aspect of the host's immune mechanism fails to prevent infection (immune deficiencies) and (2) those that occur when the immune response is directed at an inappropriate antigen, such as a noninfectious agent in an allergic

Immune deficiencies (AIDS) < Inherited
Acquired
Allergies
Autoimmune disorder
Graft rejection

reaction, the body's own antigens in an autoimmune response, or the cells of a transplanted organ in graft rejection.

The immune system may fail to function for many reasons. Many immunodeficiency disorders are caused by a genetic defect in some component of the system and thus usually manifest early in life. Some deficiencies, however, are acquired through the action of infectious agents such as viruses, through the action of immunosuppressive agents used to treat various medical conditions, and through the effects of certain disease processes such as cancer. Both inherited and acquired immune deficiencies suppress one or many aspects of the immune response, rendering the affected individual unable to resist infection unless treated by administration of immunoglobulins or by bone marrow transplant.

Inherited immune disorders undermine the immune response in a variety of ways: B lymphocytes may be unable to produce antibodies, phagocytes may be unable to digest microbes, or specific complement components may not be produced.

Acquired immune deficiency syndrome (AIDS) is caused by infection with the human immunodeficiency virus (HIV), which destroys a certain type of T lymphocyte, the helper T cell. An infected individual is susceptible to a variety of infectious organisms, including those called opportunistic pathogens, which may live benignly in the human body and cause disease only when the immune system is suppressed. Certain diseases such as Kaposi's sarcoma and *Pneumocystis carinii* pneumonia, which until recently were rarely encountered by clinicians, have become prevalent in the AIDS population and are often the cause of mortality.

Allergies

The immune system may react to any foreign substance, and consequently it can respond to innocuous materials in the same way that it responds to infectious agents. If the foreign material poses no threat to the individual, an immune response is unnecessary, but it nevertheless may ensue. This misplaced response is called an **allergy**, or **hypersensitivity**, and the foreign material is referred to as an **allergen**. Common allergens include pollen, dust, bee venom, and various foods such as shellfish. What causes one person and not another to develop an allergy is not completely understood.

An allergic response occurs in the following manner. On first exposure to the allergen, the person becomes sensitized to it—that is, develops antibodies and specific T cells to the allergen. An allergic reaction does not usually accompany this initial event. When reexposure occurs, however, symptoms of the allergic response appear. These symptoms range from the mild response of sneezing and a runny nose to the sometimes life-threatening reaction of anaphylaxis, or anaphylactic shock, symptoms of which include vascular collapse and potentially fatal respiratory distress.

Autoimmune Disorder

Immune responses can be mounted against proteins that belong to the host, giving rise to autoimmune diseases. Although the immune system naturally generates antibodies to its own cells, mechanisms exist to keep this activity in check. Two mechanisms that prevent the immune system from mounting an attack against the host's own tissues have been identified. The first involves the elimination of self-reactive lymphocytes during their development and maturation in the thymus, a lymphoid organ in the chest. Self-reactive lymphocytes present in these cell populations are destroyed when they encounter the self-antigen to which they react. Because this protective selection process is not highly efficient, some self-reactive lymphocytes survive, exit the thymus, and enter the blood and tissues. Outside the thymus a second line of defence against immune self-destruction is afforded in which self-reactive lymphocytes lose their ability to react to self-antigens when they are encountered in blood and tissues. This state is referred to as **immunologic ignorance**. Autoimmune diseases arise when this mechanism fails and self-reactive lymphocytes are activated by self-antigens in the host's own tissues, often with devastating effects. **Systemic lupus erythematosus**, **thyroiditis**, **insulin-dependent diabetes mellitus**, and **rheumatoid arthritis** are examples of this type of disorder.

Graft Rejection

Transplantation of organs and cells from one individual to another has become an important medical treatment. As are other forms of therapy, it is accompanied by certain risks. Each individual's cells have a spectrum of genetically determined cell surface protein antigens, the major histocompatibility complex (MHC) antigens, or human leukocyte antigens as they are referred to in humans. MHC antigens determine a person's tissue type just as red blood cell antigens determine blood type. Aside from siblings, especially identical twins—having the same form of each gene is extremely small. Even parents will have different tissue antigens from their children.

These differences in tissue antigens pose an obstacle to transplantation because it is highly likely that foreign donor tissue will introduce antigens in the recipient that will trigger an immune response leading to tissue death and rejection. However, by careful matching of the MHC type of donor and recipient, rejection can be diminished or avoided. Because perfect matching is possible only between identical twins or very close relatives, many transplants occur between less closely matched tissue types, and success is achieved with the administration of powerful immunosuppressive drugs.

DISEASES OF ABNORMAL CELL GROWTH

The growth of cells in the body is a closely controlled function, which, together with limited and regulated expression of various genes, gives rise to the many different tissues that constitute the whole organism. For the most part, control of cell growth persists throughout life except for episodic instances such as healing of an injured tissue. In this situation the growth of a localized group of cells is accelerated to reconstitute the tissue to its previous state of normal structure and function, following which tightly regulated growth resumes. Such areas of increased cell growth are referred to as hyperplasias; they consist of expanded numbers of normal-appearing cells and, depending on the duration of growth, can result in an enlargement of tissues and organs. In general, hyperplasias arise to meet special needs of the body and subside once these needs are met. Hyperplasias are the result of the sustained impact over time of stimulatory influences together with a loss of growth-inhibitory factors that are normally found within or around cells. As long as the loss of inhibition of cell growth is temporary, the capacity for enhanced cell proliferation when necessary has obvious advantages. However, if cells permanently lose their ability to respond to growth-inhibitory factors, their growth becomes irrepressible, and cancer may result.

Malignant and Benign Tumours

Diseases arising from uncontrolled cell growth and behaviour collectively constitute the second most common cause of human death (the most common cause being heart disease). The significance of this incidence is placed in proper perspective by a consideration of the following facts. While cancer arises at all stages of life, its incidence (number of cases) increases with age, reaching a peak between 55 and 74 years. This fact, together with the increasing longevity of the general population and improved diagnostic modalities that enable clinicians to detect cancers with greater frequency, tempers the notion that the incidence of cancer is increasing.

In addition to cancers—malignant tumours that may eventually kill the host—there are benign tumours that rarely produce serious disease. The two types of tumours are collectively referred to as neoplasms (new growths), and their study is known as oncology. Tumours are referred to as malignant or benign based on the structural and functional properties of their component cells and their biological behaviour. The cells and tissues of malignant tumours differ from the tissues from which they arise. They exhibit more rapid growth and altered structure and function, including stimulation of new blood vessel growth (angiogenesis) and a capacity to invade adjacent normal tissues, enter the blood vascular system, and spread (metastasize) to distant sites. The properties of malignant tumour cells serve to enhance and support their proliferation and extension throughout the body tissues and organs, eventually leading to death of the host. In contrast, the cells and tissues of benign tumours tend to grow more slowly and in general closely resemble their normal tissues of origin. When the structure and function of benign tumour cells are morphologically and functionally indistinguishable from those of normal cells, their growth as a

tumour mass is the sole feature indicative of their neoplastic nature. It is hoped that a greater understanding of malignant cell growth and behaviour will lead to the development of novel cancer therapies based on tumour cell biology that will complement or replace the current treatments of surgical extirpation (complete excision), chemotherapy, and radiation.

Epidemiology of Cancer

- ✓ Epidemiological studies of the worldwide incidence of cancers have identified striking differences among countries and population groups. For example, the incidence of and death rates for skin cancer are much higher in Australia and New Zealand than in the Scandinavian countries—presumably because of the marked differences between these two regions in total annual hours of exposure to sunlight. The importance of environmental influences is highlighted by comparing the incidence of and death rates for cancers among populations in different geographic regions. For example, prostate and colon cancer rates in Japanese persons living in Japan differ from the rates in Japanese persons who have emigrated to the United States, the rates of their offspring born in California, and the rates of long-term white residents of that state. These rates are much lower among Japanese living in Japan than they are in white Californians. However, the rates for each type of tumour among first-generation Japanese immigrants are intermediate between the rates in Japan and those in California, suggesting that environmental and cultural factors may play a more important role than genetic ones.

Genetics of Cancer

- ✓ The irreversibility of the structural and behavioral changes of cancer cells has long been recognized and has favoured the postulate that they are probably due to permanent genetic alterations. This postulate remained speculative until the discovery in 1979 that oncogenes (cancer-causing genes) are derived from proto-oncogenes (normal growth-regulatory cellular genes). When proto-oncogenes become mutated or deregulated, they are converted to oncogenes, which are capable of causing the malignant transformation of cells, including those of humans. Cellular proto-oncogenes code for proteins involved in cell regulation. Thus, changes in the structure of proto-oncogenes and their conversion to oncogenes results in the synthesis of abnormal proteins that are incapable of carrying out their usual growth-regulatory functions. In identifying the genes involved in the development of cancer, researchers discovered a group of cellular genes—tumour-suppressor, or suppressor, genes—whose protein products normally negatively regulate cell growth by suppressing cell proliferation, thus counterbalancing the growth-stimulatory effects of proteins synthesized by proto-oncogenes. Genetic analyses of various animal and human cancers have demonstrated that, in the majority, alterations of oncogenes and suppressor genes were often simultaneously present. These analyses suggest that multiple genetic alterations involving growth-stimulatory and growth-inhibitory genes are required for the induction of malignancy. Such discoveries have ushered in a new era in cancer biology and may well lead to the eventual control, cure, and prevention of malignant diseases.

Heredity and Environment

The many causes of cancer include intrinsic factors, such as heredity, and extrinsic factors, such as environment and lifestyle. Hereditary causes of cancer are less common and are due to the inheritance of a single mutant gene that greatly increases the risk of developing a malignant tumour. Such cancers include (1) a childhood tumour of the eye, **retinoblastoma**, and a bone tumour, **osteosarcoma**, both of which involve the loss of a tumour suppressor gene, and (2) familial **adenomatous polyposis**, in which all patients develop colon cancer by age 50. The most common types of cancer that occur sporadically, such as cancers of the breast, ovary, colon, and pancreas, also have been documented to occur in familial forms. The children in such families appear to have a two to threefold increased risk of developing a particular tumour, but the transmission pattern is unclear. A still rarer hereditary cause of cancer is an inherited deficiency in the ability to repair DNA. Patients with this defect (known as **xeroderma pigmentosum**) are particularly sensitive to sunlight and develop skin cancer during early adolescence because of unrepaired mutations induced by ultraviolet (UV) light.

Anthropology Paper 01 - Volume 01

Although the environment contains many agents that can cause cancer in humans, the extent to which they contribute to the human disease is often difficult to assess. For example, the link between tobacco smoking and lung cancer is clear; however, little is known about the cause of cancer of the prostate, the most common form of cancer in males, despite the fact that many factors—including age, race, male hormone, increased consumption of dietary fat, and a genetic basis—have been implicated.

Three categories of carcinogens (chemical or physical agents that mutate DNA) that induce cancer in experimental animals and humans have been identified in the environment: (1) chemicals, (2) radiant energy, and (3) oncogenic viruses.

DISEASES OF ENDOCRINE ORIGIN

Endocrine Glands are a group of ductless glands that regulate body processes by secreting chemical substances called hormones. Hormones act on nearby tissues or are carried in the bloodstream to act on specific target organs and distant tissues. Diseases of the endocrine system can result from the oversecretion or undersecretion of hormones or from the inability of target organs or tissues to respond to hormones effectively.

It is important to distinguish between an endocrine gland, which discharges hormones into the bloodstream, and an exocrine gland, which secretes substances through a duct opening in a gland onto an external or internal body surface. Salivary glands and sweat glands are examples of exocrine glands. Both saliva, secreted by the salivary glands, and sweat, secreted by the sweat glands, act on local tissues near the duct openings. In contrast, the hormones secreted by endocrine glands are carried by the circulation to exert their actions on tissues remote from the site of their secretion.

The endocrine system, in association with the nervous system and the immune system, regulates the body's internal activities and the body's interactions with the external environment to preserve the internal environment. This control system permits the prime functions of living organisms—growth, development, and reproduction—to proceed in an orderly, stable fashion; it is exquisitely self-regulating, so that any disruption of the normal internal environment by internal or external events is resisted by powerful countermeasures. When this resistance is overcome, illness ensues.

Other body tissues may also function as endocrine organs. Examples include the lungs, the heart, the skeletal muscles, the kidneys, the lining of the gastrointestinal tract, and bundles of nerve cells called nuclei. While all nerve cells are capable of secreting neurotransmitters into the synapses (small gaps) between adjacent nerves, nerve cells that regulate certain endocrine functions—for example, the nerve cells of the posterior pituitary gland secrete neurohormones directly into the bloodstream.

Diseases Names required (?)

are of 3 groups

Endocrine gland hyposecretion

Ex: Addison's disease

" " hyper "

Ex: Cushing's syndrome

Tumours of endocrine glands
(benign or malignant)

Ex: Adrenocortical carcinoma

Glands and hormones of the human endocrine system		
gland or tissue	principal hormone	function
testis	testosterone	stimulates development of male sex organs and secondary sex characteristics, including <u>facial hair growth</u> and <u>increased muscle mass</u>
ovary	estrogens (estradiol, estrone, estriol)	stimulate development of female sex organs and secondary sex characteristics, maturation of ovarian follicles, <u>formation</u> and <u>maintenance of bone tissue</u> , and contraction of the uterine muscles
	inhibin (folliculostatin)	inhibits secretion of follicle-stimulating hormone from the pituitary gland
	progesterone	stimulates secretion of substances from the lining of the uterus (endometrium) in preparation for egg implantation in the uterine wall
	relaxin	induces relaxation of pubic ligaments during childbirth to facilitate infant delivery
thyroid gland	thyroxine	stimulates cellular metabolism, lipid production, carbohydrate utilization, and central and autonomic nervous system activation
	triiodothyronine	stimulates cellular metabolism, lipid production, carbohydrate utilization, and central and autonomic nervous system activation
adrenal gland, medulla	epinephrine (adrenaline)	stimulates "fight or flight" response, increases heart rate, dilates blood vessels in skeletal muscles and liver, increases oxygen delivery to muscle and brain tissues, increases blood glucose concentrations, and suppresses digestion
	norepinephrine (noradrenaline)	stimulates "fight or flight" response, increases heart rate, constricts blood vessels, increases blood glucose concentrations, and suppresses digestion
adrenal gland, cortex	cortisol	activates physiological stress responses to maintain blood glucose concentrations, augments constriction of blood vessels to maintain blood pressure, and stimulates anti-inflammatory pathways
	aldosterone	regulates balance of salt and water in the body
	androgens	contribute to growth and development of the male reproductive system and serve as precursors to testosterone and estrogen
pituitary gland, anterior lobe	corticotropin (adrenocorticotropin, ACTH)	stimulates growth and secretion of cells of the adrenal cortex; increases skin pigmentation
	growth hormone (GH; somatotropin)	stimulates growth of essentially all tissues in the body
	thyrotropin (thyroid-stimulating hormone)	stimulates secretion of thyroid hormone and growth of thyroid cells
	follicle-stimulating hormone (FSH)	stimulates maturation of egg follicles in females and development of spermatozoa in males
	luteinizing hormone (LH; interstitial cell stimulating hormone, ICSH)	stimulates rupture of mature egg follicles and production of progesterone and androgens in females and secretion of androgens in males
	prolactin (PRL; lactotropic hormone, LTH; lactogenic hormone; mammotropin)	stimulates and maintains lactation in breast-feeding mothers

Anthropology Paper 01 - Volume 01

pituitary gland, posterior lobe	oxytocin	stimulates milk ejection during breast-feeding and uterine muscle contraction during childbirth
	vasopressin (antidiuretic hormone, ADH)	regulates fluid volume by increasing or decreasing fluid excretion in response to changes in blood pressure
pituitary gland, intermediate lobe	melanocyte-stimulating hormones (MSH)	stimulate melanin synthesis in skin cells to increase skin pigmentation; may also suppress appetite
hypothalamus	corticotropin-releasing hormone (CRH)	stimulates synthesis and secretion of corticotropin from the anterior pituitary gland
	growth hormone-releasing hormone (GHRH)	stimulates synthesis and secretion of growth hormone from the anterior pituitary gland
	thyrotropin-releasing hormone (TRH)	stimulates and regulates secretion of thyrotropin from the anterior pituitary gland and may modulate neuronal activity in the brain and spinal cord
	gonadotropin-releasing hormone (GnRH)	stimulates synthesis and secretion of follicle-stimulating hormone and luteinizing hormone from the anterior pituitary gland
	prolactin-inhibiting factor (PIF; dopamine)	inhibits secretion of prolactin from the anterior pituitary gland
	somatostatin	inhibits secretion of growth hormone from the anterior pituitary gland, inhibits secretion of insulin and glucagon in the pancreas, and inhibits secretion of gastrointestinal hormones and secretion of acid in the stomach
	gastrointestinal neuropeptides	hormones secreted from the stomach and pancreas that stimulate hypothalamic secretion of neuropeptides, such as neuropeptide Y, gastrin-releasing peptide, and somatostatin, that regulate appetite, fat storage, and metabolism
pancreatic islets of Langerhans	glucagon	maintains blood glucose concentrations by stimulating release of glucose from the liver and production of glucose from amino acids and glycerol
	insulin	stimulates glucose uptake and storage in adipose, muscle, and liver tissues
	somatostatin	inhibits glucagon and insulin secretion from the pancreas and inhibits secretion of gastrointestinal hormones and secretion of acid in the stomach
	pancreatic polypeptide	inhibits contraction of the gallbladder and secretion of exocrine substances from the pancreas
parathyroid gland	parathyroid hormone (parathormone)	increases serum calcium concentrations by stimulating release of calcium from bone tissue, reabsorption of calcium in the kidneys, and production of vitamin D in the kidneys; inhibits reabsorption of phosphate in the kidneys
	calcitonin	decreases serum calcium concentrations by promoting uptake of calcium into bone tissue and excretion of calcium in the urine
skin, liver, kidneys	calciferols (vitamin D)	maintain serum calcium concentrations by increasing absorption of calcium and phosphate in the intestines and reabsorption of calcium and phosphate in the kidneys; mobilizes calcium from bone in response to parathyroid hormone activity
stomach	gastrin	stimulates secretion of acid and pepsin in the stomach and contraction of the pyloric region of the stomach near the small intestine to increase motility during digestion

duodenum	cholecystokinin (CCK; pancreozymin)	stimulates release of bile from the gallbladder into the intestine and stimulates secretion of pancreatic juices into the intestine; may induce satiety
	secretin	stimulates secretion of water and bicarbonate from the pancreas into the duodenum; inhibits secretion of gastrin in the stomach, delaying gastric emptying
	gastric-inhibitory polypeptide (GIP)	inhibits secretion of acid into the stomach; stimulates secretion of insulin from the pancreas
	vasoactive intestinal peptide (VIP)	stimulates dilation of blood vessels and secretion of water and electrolytes from the intestine; modulates immune functions
pineal gland	melatonin	regulates circadian rhythm (primarily in response to light and dark cycles) and release of gonadotropin-releasing hormone from the hypothalamus and gonadotropins from the pituitary gland
kidneys	renin	regulates blood pressure and blood flow by catalyzing conversion of angiotensinogen to angiotensin I in the kidneys
multiple tissues	insulin-like growth factors (somatomedins)	stimulate growth by mediating secretion of growth hormone from the pituitary gland
	prostaglandins	regulate many physiological processes, including dilation and constriction of blood vessels, aggregation of platelets, and inflammation

(5)

DISEASES OF NEUROPSYCHIATRIC ORIGIN

psychiatric — schizophrenia, depression, mania

neurological — Alzheimer's, Huntington's, Parkinson's, chorea.

Diseases of neuropsychiatric origin afflict large segments of the population. For example, a total of about 2.8 million persons in the United States alone suffer from three major psychiatric diseases—schizophrenia, major depression, and mania—and three major neurological disorders—Alzheimer's disease, Huntington's chorea, and Parkinson's disease.

The key function of the nervous system is to collect information about the body and its external environment, process the information, and coordinate the body's responses to that information. This complex function depends on each nerve cell (neuron) receiving signals from other neurons and transmitting this input to still other neurons. This critical input and output of communication (signaling) between neurons is mediated by chemical transmitter molecules (neurotransmitters). Neurotransmitters are synthesized by nerve cells and released from one cell to another across a narrow gap between the two neurons known as the synapse. Eight different major neurotransmitters and a large number of neuropeptide molecules (which serve to modulate the effects of neurotransmitters) have been identified. Different types of nerve cells respond to different neurotransmitters and neuropeptides. Chemical signaling between nerve cells is rapid and precise and can occur over long distances. The precision is due to receptor molecules, which are activated following their recognition and binding of specific neurotransmitters. In some types of nerves the synapses do not possess receptors, in which case interneuronal communication is achieved by electrical transmission. In many neuropsychiatric diseases alterations in the levels of transmitter substances appear to play a major role in pathogenesis.

Psychiatric Diseases

Mental illnesses affect the very fabric of human nature, robbing it of its various facets of personality, purposeful behaviour, abstract thinking, creativity, emotion, and mood. Those suffering from mental disorders exhibit a spectrum of symptoms depending on the severity of their disease. These diseases include obsessive-compulsive personality disorder, dementia, schizophrenia, major depression, and manic disorders.

Schizophrenia in its severe form is a catastrophic mental illness that begins in adolescence or early adult life. It is relatively common, occurring in about 1 percent of the general population worldwide. Because the incidence of schizophrenia among parents, children, and siblings of patients with the disease is increased to 15 percent, it is believed that heredity plays an important role in the genesis of the disease. However, other studies suggest that nongenetic factors are also influential. The biochemical basis of the disease may be an excess of the neurotransmitter substance dopamine, as high levels of dopamine and its metabolites, as well as increased dopamine receptors, are found in the brains of persons with schizophrenia. Further evidence for this hypothesis is that the drugs most effective in treating the disease are those that have a high capacity to block dopamine receptors.

Pathological disturbances of mood, ranging from severe depression to manic behaviour, are common forms of mental illnesses. Severe depression is characterized by despondency, diminished interest in most or all activities, weight fluctuation not due to dieting, disruption in sleep patterns, psychomotor agitation or retardation, feelings of worthlessness, excessive quiet, and recurrent thoughts of death or suicide. Manic behaviour involves a period in which an expansive, elevated, or irritable mood persists abnormally. During this episode symptoms such as increased talkativeness, distractibility, decreased need for sleep, inflated self-esteem, and excessive involvement in pleasurable yet risky activities may be present. Major depression is associated with decreased brain levels of the neurotransmitters norepinephrine and serotonin, and the most effective therapy consists of drugs that inhibit the breakdown of these compounds. The neurochemical alterations in mania are less clearly understood, but it is well established that drugs effective in the treatment of mania are those that antagonize dopamine and serotonin. Although mood disorders have a familial background, the evidence for a genetic component is not convincing.

Neurological Diseases

The three neurological diseases considered in this section—Alzheimer's disease, Huntington's chorea, and Parkinson's disease—are age-related, and to varying degrees they manifest as deterioration of mental function that involves the loss of memory and of acquired intellectual skills. This deterioration is referred to as dementia. Because dementia can result from many causes, other features of each disease must be present before a definitive diagnosis can be made.

Alzheimer's disease is the most common form of dementia, being responsible for about two-thirds of the cases of dementia in patients over 60 years of age. Women are affected twice as often as men. More rarely there are familial forms of the disease that have an early onset affecting individuals in the fourth and fifth decades of life. Early manifestations include memory loss, temporary confusion, restlessness, poor judgment, and lethargy. A failure to retain new information and a deterioration of social relationships often ensue. In some patients paranoia and delusions, which worsen during the night, are the first symptoms of the disease. Whatever the onset, the last stages are characterized by intellectual vacuity and loss of control over all body functions. The brains of patients with Alzheimer's disease are characterized by the loss of neurons, which, as the disease progresses, becomes severe and leads to decreased brain size and weight. A variety of genetic factors have been identified in the different forms of Alzheimer's disease. The rare cases of the early familial forms of the disease are linked to three different genetic defects found on three different chromosomes—chromosomes 1, 14, and 21. Another gene on chromosome 19 is believed to play a part in the more common late-onset cases.

Huntington's chorea occurs at the rate of about 5 per 100,000 individuals. It affects both sexes equally and usually becomes manifest in the fourth decade of life. The disorder is characterized by uncontrolled movements (chorea), dementia, and death within 20 years after onset. The symptoms worsen until the patient becomes totally incapacitated and bedridden. Huntington's chorea is a hereditary disease passed on as an autosomal dominant trait (see above Diseases of genetic origin). Because of its highly regular familial inheritance, the disease is often traceable to the original carriers who introduced the defective gene. The recent localization of the Huntington's chorea gene to chromosome 4 and its cloning will allow identification of the gene product, insight into the mechanism responsible for the disease, and perhaps

effective treatment. It will also permit the disease to be diagnosed in fetuses as well as in children before the onset of symptoms.

Parkinson's disease is a motor disorder characterized by the onset of a rhythmic tremor, muscle rigidity, difficulty and slowness in movement, and stooped posture. As the disease progresses, the face of the patient becomes expressionless, the rate of swallowing is reduced, leading to drooling, and depression and dementia increase. The prevalence of Parkinson's disease is estimated to be about 160 per 100,000 persons in the general population, with about 16 to 19 new cases per 100,000 appearing each year. Men are slightly more affected than women, and there are no apparent racial differences. The disease appears typically in the sixth and seventh decades, although occasionally it can begin as early as the third decade. Parkinson's disease has no known cause. A marked decrease in the level of dopamine, a major neurotransmitter, has been noted in the brains of patients with Parkinson's disease, and this change has been attributed to the loss of so-called dopaminergic neurons that normally synthesize and use dopamine to communicate with other neurons in parts of the brain that regulate motor function.

INFECTIOUS DISEASES

Infection is the invasion of the body by various agents—including bacteria, fungi, protozoans, viruses, and worms—and its reaction to them or their toxins.

Infections are called subclinical until they perceptibly affect health, when they become infectious diseases. Infection can be local (e.g., an abscess), confined to one body system (e.g., pneumonia in the lungs), or generalized (e.g., septicemia). Infectious agents can enter the body by inhalation, ingestion, sexual transmission, passage to a fetus during pregnancy or birth, wound contamination, or animal or insect bites. The body responds with an attack on the invader by leukocytes, production of antibodies or antitoxins, and often a rise in temperature. The antibodies may result in short-term or lifelong immunity. Despite significant progress in preventing and treating infectious diseases, they remain a major cause of illness and death, particularly in regions of poor sanitation, poor nutrition, and crowding.

The most important barriers to invasion of the human host by microorganisms are the skin and mucous membranes (the tissues that line the nose, mouth, and upper respiratory tract). When these tissues have been broken or affected by earlier disease, invasion by microorganisms may occur. These microorganisms may produce a local infectious disease, such as boils, or may invade the bloodstream and be carried throughout the body, producing generalized bloodstream infection (septicemia) or localized infection at a distant site, such as meningitis (an infection of the coverings of the brain and spinal cord). Infectious agents swallowed in food and drink can attack the wall of the intestinal tract and cause local or general disease. The conjunctiva, which covers the front of the eye, may be penetrated by viruses that cause a local inflammation of the eye or that pass into the bloodstream and cause a severe general disease, such as smallpox. Microorganisms can enter the body through the genital tract, causing the acute inflammatory reaction of gonorrhea in the genital and pelvic organs or spreading out to attack almost any organ of the body with the more chronic and destructive lesions of syphilis. Even before birth, viruses and other infectious agents can pass through the placenta and attack developing cells, so that an infant may be diseased or deformed at birth.

From conception to death, humans are targets for attack by multitudes of other living organisms, all of them competing for a place in the common environment. The air people breathe, the soil they walk on, the waters and vegetation around them, the buildings they inhabit and work in, all can be populated with forms of life that are potentially dangerous. Domestic animals may harbour organisms that are a threat, and wildlife teams with agents of infection that can afflict humans with serious disease. However, the human body is not without defences against these threats, for it is equipped with a comprehensive immune system that reacts quickly and specifically against disease organisms when they attack. Survival throughout the ages has depended largely on these reactions, which today are supplemented and strengthened through the use of medical drugs.

Categories of Organisms: The agents of infection can be divided into different groups on the basis of their size, biochemical characteristics, or manner in which they interact with the human host. The groups of organisms that cause infectious diseases are categorized as bacteria, viruses, Chlamydia, rickettsias, mycoplasmas and ureaplasmas, fungi, and parasites.

Bacteria

- 1. Aerobes Anaerobes Bacteria can survive within the body but outside individual cells. Some bacteria, classified as aerobes, require oxygen for growth, while others, such as those normally found in the small intestine of healthy persons, grow only in the absence of oxygen and, therefore, are called anaerobes. Most bacteria are surrounded by a capsule that appears to play an important role in their ability to produce disease. Also, a number of bacterial species give off toxins that, in turn, may damage tissues. Bacteria are generally large enough to be seen under a light microscope. Streptococci, the bacteria that cause scarlet fever, are about 0.75 micrometre (0.00003 inch) in diameter. The spirochetes, which cause syphilis, leptospirosis, and rat-bite fever, are 5 to 15 micrometres long. Bacterial infections can be treated with antibiotics.
- 2. Bacterial infections are commonly caused by pneumococci, staphylococci, and streptococci, all of which are often commensals (that is, organisms living harmlessly on their hosts) in the upper respiratory tract but that can become virulent and cause serious conditions, such as pneumonia, septicemia (blood poisoning), and meningitis. The pneumococcus is the most common cause of lobar pneumonia, the disease in which one or more lobes, or segments, of the lung become solid and airless as a result of inflammation. Staphylococci affect the lungs either in the course of staphylococcal septicemia—when bacteria in the circulating blood cause scattered abscesses in the lungs—or as a complication of a viral infection, commonly influenza—when these organisms invade the damaged lung cells and cause a life-threatening form of pneumonia. Streptococcal pneumonia is the least common of the three and occurs usually as a complication of influenza or other lung disease.
- 3. Pneumococci often enter the bloodstream from inflamed lungs and cause septicemia, with continued fever but no other special symptoms. Staphylococci produce a type of septicemia with high, swinging fever; the bacteria reach almost any organ of the body, the brain, the bones, and especially the lungs, and destructive abscesses form in the infected areas. Streptococci also cause septicemia with fever, but the organisms tend to cause inflammation of surface lining cells rather than abscesses—for example, pleurisy (inflammation of the chest lining) rather than lung abscess, and peritonitis (inflammation of the membrane lining the abdomen) rather than liver abscess. In the course of either of the last two forms of septicemia, organisms may enter the nervous system and cause streptococcal or staphylococcal meningitis, but these are rare conditions. Pneumococci, on the other hand, often spread directly into the central nervous system, causing one of the common forms of meningitis.
- 4. Staphylococci and streptococci are common causes of skin diseases. Boils and impetigo (in which the skin is covered with blisters, pustules, and yellow crusts) may be caused by either. The staphylococcus also can cause a severe skin infection that strips the outer skin layers off the body and leaves the underlayers exposed, as in severe burns, a condition known as toxic epidermal necrolysis. In the 1980s causes of severe streptococcal necrotizing fasciitis, causing disease and death, began to be noticed. Streptococci can be the cause of the red cellulitis of the skin known as erysipelas.

Some staphylococci produce an intestinal toxin and cause food poisoning. Streptococci settling in the throat produce a reddening toxin that speeds through the bloodstream and produces the symptoms of scarlet fever. Streptococci and staphylococci also can cause toxic shock syndrome, a potentially fatal disease.

Meningococci are fairly common inhabitants of the throat, in most cases causing no illness at all. As the number of healthy carriers increases in any population, however, there is a tendency for the meningococcus to become more invasive. When an opportunity is presented, it can gain access to the bloodstream, invade the central nervous system, and cause meningococcal meningitis (formerly called cerebrospinal meningitis or spotted fever). Meningococcal meningitis, at one time a dreaded and still a

very serious disease, usually responds to treatment with penicillin if diagnosed early enough. When meningococci invade the bloodstream, some gain access to the skin and cause bloodstained spots, or purpura. If the condition is diagnosed early enough, antibiotics can clear the bloodstream of the bacterium and prevent any from getting far enough to cause meningitis. Sometimes the septicemia takes a mild, chronic, relapsing form with no tendency toward meningitis; this is curable once it is diagnosed. The meningococcus also can cause one of the most fulminating of all forms of septicemia, meningococcemia, in which the body is rapidly covered with a purple rash, purpura fulminans; in this form the blood pressure becomes dangerously low, the heart and blood vessels are affected by shock, and the infected person dies within a matter of hours. Few are saved, despite treatment with appropriate drugs.

Haemophilus influenzae is a microorganism named for its occurrence in the sputum of patients with influenza—an occurrence so common that it was at one time thought to be the cause of the disease. It is now known to be a common inhabitant of the nose and throat that may invade the bloodstream, producing meningitis, pneumonia, and various other diseases. In children it is the most common cause of acute epiglottitis, an infection in which tissue at the back of the tongue becomes rapidly swollen and obstructs the airway, creating a potentially fatal condition. H. influenzae also is the most common cause of meningitis and pneumonia in children under five years of age, and it is known to cause bronchitis in adults. The diagnosis is established by cultures of blood, cerebrospinal fluid, or other tissue from sites of infection. Antibiotic therapy is generally effective, although death from sepsis or meningitis is still common. In developed countries where H. influenzae vaccine is used, there has been a great decrease in serious infections and deaths.

Viruses

Viruses are not, strictly speaking, living organisms. Instead, they are nucleic acid fragments packaged within protein coats that require the machinery of living cells to replicate. Viruses are visible by electron microscopy; they vary in size from about 25 nanometres for poliovirus to 250 nanometres for smallpox virus. Vaccination has been the most successful weapon against viral infection; some infections may be treated with antiviral drugs.

✓ Viruses of the Herpesviridae family cause a multiplicity of diseases. Those causing infections in humans are the varicella-zoster virus (VZV), which causes chickenpox and herpes zoster (shingles); the Epstein-Barr virus, which causes infectious mononucleosis; the cytomegalovirus, which is most often associated with infections of newborn infants and immunocompromised people; and herpes simplex virus, which causes cold sores and herpetic venereal (sexually transmitted) diseases.

There are two serotypes of herpes simplex virus, HSV-1 and HSV-2. HSV-1 is the common cause of cold sores. The primary infection usually occurs in childhood and is without symptoms in 50 to 80 percent of cases. Between 10 and 20 percent of infected individuals have recurrences precipitated by emotional stress or by other illness. HSV-1 can also cause infections of the eye, central nervous system, and skin. Serious infections leading to death may occur in immunocompromised persons. HSV-2 is associated most often with herpetic lesions of the genital area. The involved area includes the vagina, cervix, vulva, and, occasionally, the urethra in females and the head of the penis in males; it may also cause an infection at the site of an abrasion. The disease is usually transmitted by sexual contact. In herpetic venereal diseases, the lesions are small, red, painful spots filled with fluid, and quickly rupture, leaving eroded areas that eventually become scabbed. These primary lesions occur from two to eight days after exposure and may be present for up to three weeks. Viral shedding and pain usually resolve in two weeks. When infections recur, the duration of the pain, lesions, and viral shedding is approximately 10 days.

Chlamydia

Chlamydia are intracellular organisms found in many vertebrates, including birds and humans and other mammals. Clinical illnesses are caused by two species, C. trachomatis and C. psittaci. The former is a frequent cause of genital infections in women, and, if an infant passes through an infected birth canal, it can produce disease of the eye (conjunctivitis) and pneumonia in the newborn. Young children

Anthropology Paper 01 - Volume 01

sometimes develop ear infections, laryngitis, and upper respiratory tract disease from Chlamydia. Such infections can be treated with erythromycin.

C. psittaci produces psittacosis, a disease that results from exposure to the discharges of infected birds. The illness is characterized by high fever with chills, a slow heart rate, pneumonia, headache, weakness, fatigue, muscle pains, anorexia, nausea, and vomiting. The diagnosis is usually suspected if the patient has a history of exposure to birds and is confirmed by blood tests. Mortality is rare, and specific antibiotic treatment is available.

Rickettsias

The rickettsias are a family of microorganisms named for American pathologist Howard T. Ricketts, who died of typhus in 1910 while investigating the spread of the disease. The rickettsias, which range in size from 250 nanometres to more than 1 micrometre and have no cell wall but are surrounded by a cell membrane, cause a group of diseases characterized by fever and a rash. Except for Coxiella burnetii, the cause of Q fever, they are intracellular parasites, most of which are transmitted to humans by an arthropod carrier such as a louse or tick. *C. burnetii*, however, can survive in milk, sewage, and aerosols and can be transmitted to humans by a tick or by inhalation, causing pneumonia in the latter case. Rickettsial diseases can be treated with antibiotics.

Humans contract most rickettsial diseases only when they break into a cycle in nature in which the rickettsias live. In murine typhus, for example, Rickettsia mooseri is a parasite of rats conveyed from rat to rat by the rat flea, *Xenopsylla cheopis*; it bites humans if they intrude into its environment. Scrub typhus is caused by *R. tsutsugamushi*, but it normally parasitizes only rats and mice and other rodents, being carried from one to the other by a small mite, *Leptotrombidium* (previously known as *Trombicula*). This mite is fastidious in matters of temperature, humidity, and food and finds everything suitable in restricted areas, or "mite islands," in South Asia and the western Pacific. It rarely bites humans in their normal environment, but if people invade its territory en masse it will attack, and outbreaks of scrub typhus will follow.

The spotted fevers are caused by rickettsias that spend their normal life cycles in a variety of small animals, spreading from one to the other inside ticks; these bite human intruders and cause African, North Asian, and Queensland tick typhus, as well as Rocky Mountain spotted fever. One other spotted fever, rickettsialpox, is caused by *R. akari*, which lives in the body of the ordinary house mouse, *Mus musculus*, and spreads from one to another inside the house mite *Allodermanyssus sanguineus*. This rickettsia is probably a parasite of wild field mice, and it is perhaps only when cities push out into the countryside that house mice catch the infection.

Mycoplasmas and Ureaplasmas

Mycoplasmas and ureaplasmas, which range in size from 150 to 850 nanometres, are the smallest free-living microorganisms. They are ubiquitous in nature and capable of causing widespread disease, but the illnesses they produce in humans are generally milder than those caused by bacteria. Diseases due to mycoplasmas and ureaplasmas can be treated with antibiotics.

Mycoplasma pneumoniae is the most important member of its genus. *M. pneumoniae* is associated with 20 percent of all cases of pneumonia in adults and children over five years of age. Patients have fever, cough, headache, and malaise and, upon physical examination, may be found to have pharyngitis (inflamed throat), enlarged lymph nodes, ear or sinus infection, bronchitis, or croup. Diagnosis is established by chest X-rays and blood tests. Although treatment with erythromycin or tetracycline may shorten the illness, it can last for weeks.

Mycoplasmas may also cause a red, bumpy rash—usually on the trunk or back—that is occasionally vesicular (with blisters). Inflammation of the heart muscle and the covering of the heart (pericardium) is rare but can be caused by mycoplasmas. About one-fourth of the people infected with these organisms

experience nausea, vomiting, diarrhea, and cramping abdominal pain. Inflammation of the pancreas (pancreatitis) or the liver (hepatitis) may occur, and infection of the brain and spinal cord is a serious complication.

Ureaplasmas can be recovered frequently from the genital areas of healthy persons. The organism can cause inflammation of the urethra and has been associated with infertility, low birth weight of infants, and repeated stillbirths. In general, however, ureaplasma infections are mild. Tetracycline is the preferred treatment once the organism has been established as the cause of infection by microscopic examination of urethral secretions.

Fungi

Fungi are large organisms that usually live on dead and rotting animal and plant matter. They are found mostly in soil, on objects contaminated with soil, on plants and animals, and on skin, and they may also be airborne. Fungi may exist as yeasts or molds and may alternate between the two forms, depending on environmental conditions. Yeasts are simple cells, 3 to 5 micrometres (0.0001 to 0.0002 inch) in diameter. Molds consist of filamentous branching structures (called hyphae), 2 to 10 micrometres in diameter, that are formed of several cells lying end to end. Fungal diseases in humans are called mycoses; they include such disorders as histoplasmosis, coccidioidomycosis, and blastomycosis. These diseases can be mild, characterized by an upper respiratory infection, or severe, involving the bloodstream and every organ system. Fungi may cause devastating disease in persons whose defenses against infection have been weakened by malnutrition, cancer, or the use of immunosuppressive drugs. Specific types of antibiotics known as antifungals are effective in their treatment.

Parasites

Among the infectious parasites are the protozoans, unicellular organisms that have no cell wall, that cause such diseases as malaria. The various species of malarial parasites are about 4 micrometres (0.0002 inch) in diameter. At the other extreme, the tapeworm can grow to several metres in length; treatment is designed either to kill the worm or to dislodge it from its host.

The worm Ascaris lumbricoides causes ascariasis, one of the most prevalent infections in the world. Ascaris lives in the soil, and its eggs are ingested with contaminated food. The eggs hatch in the human intestine, and the worms then travel through the bloodstream to the liver, heart, and lungs. They can cause pneumonia, perforations of the intestine, or blockage of the bile ducts, but infected people usually have no symptoms beyond the passage of worms in the stool. Specific treatment is available and prognosis is excellent.

Infections are also caused by whipworms, genus Trichuris, and pinworms, Enterobius vermicularis, each popularly named for its shape. The former is parasitic in the human large intestine and may cause chronic diarrhea. The latter can be found throughout the gastrointestinal tract, especially in children, and can cause poor appetite, loss of weight, anemia, and itching in the anal area (where it lays its eggs). Both conditions are easily diagnosed and treated with drugs.

Modes of Survival of Infectious Agents

Infectious agents have various methods of survival. Some depend on rapid multiplication and rapid spread from one host to another. For example, when the measles virus enters the body, it multiplies for a week or two and then enters the bloodstream and spreads to every organ. For several days before a rash appears, the surface cells of the respiratory tract are bursting with measles virus, and vast quantities are shed every time the infected person coughs or sneezes. A day or two after the rash appears, the amount of antibody rises in the bloodstream, neutralizing the virus and stopping further shedding. The patient rapidly becomes noninfectious but already may have spread the virus to others. In this way an epidemic can rapidly occur. Many other infectious agents—for example, influenza virus—survive in this manner. How such viruses exist between epidemics is, in some cases, less clear.

Anthropology Paper 01 - Volume 01

The picture is different in more-chronic infections. In tuberculosis there is neither overwhelming multiplication nor rapid shedding of the tubercle bacillus. Rather, the bacilli remain in the infected person's body for a long period, slowly forming areas of chronic inflammation that may from time to time break down and allow them to escape.

Some organisms form spores, a resting or dormant stage that is resistant to heat, cold, drying, and chemical action. Spore-forming organisms can survive for months or years under the most adverse conditions and may not, in fact, be highly infectious. The bacterium that causes tetanus, Clostridium tetani, is present everywhere in the environment—in soil, in dust, on window ledges and floors—and yet tetanus is an uncommon disease, especially in developed countries. The same is true of the anthrax bacterium, Bacillus anthracis. Although usually present in abundance in factories in which rawhides and animal wool and hair are handled, it rarely causes anthrax in employees. Clostridium botulinum, the cause of botulism, produces one of the most lethal toxins that can afflict humans, and yet the disease is one of the rarest because the microorganism depends for its survival on its resistant spore.

In contrast to these relatively independent organisms, there are others that cannot exist at all outside the human body. The germs of syphilis and gonorrhea, for example, depend for survival on their ability to infect and their adaptation to the human environment.

Some organisms have complicated life cycles and depend on more than one host. The malarial parasite must spend a portion of its life cycle inside a mosquito, while the liver fluke Fasciola hepatica, an occasional human parasite, spends part of its life in the body of a land animal such as a sheep, part in a water snail, and part in the open air as a cyst attached to grass.

Commensal Organisms

All of the outer surfaces of the human body are covered with microorganisms that normally do no harm and may, in fact, be beneficial. Those commensal organisms on the skin help to break down dying skin cells or to destroy debris secreted by the many minute glands and pores that open on the skin. Many of the organisms in the intestinal tract break down complex waste products into simple substances, and others help in the manufacture of chemical compounds that are essential to human life.

The gastrointestinal tract is considered in this regard to be one of these "outer" surfaces since it is formed by the intucking, or invagination, of the ectoderm, or outer surface, of the body. The mouth, nose, and sinuses (spaces inside the bones of the face) are also considered to be external structures because of their direct contact with the outside environment. Both the gastrointestinal tract and the mouth, nose, and sinuses are heavily populated with microorganisms, some of which are true commensals—living in humans and deriving their sustenance from the surface cells of the body without doing any harm—and others of which are indistinguishable from disease germs. The latter may live like true commensals in a particular tract in a human and never cause disease, despite their potential to do so. When the environment is altered, however, they are capable of causing severe illness in their host, or, without harming their host, they may infect another person with a serious disease.

It is not known why, for example, the hemolytic streptococcus bacterium can live for months in the throat without causing harm and then suddenly cause an acute attack of tonsillitis or how an apparently harmless pneumococcus gives rise to pneumonia. Similarly, it is not understood how a person can harmlessly carry Haemophilus influenzae type B in the throat but then become ill when the organism invades the body and causes one of the most severe forms of meningitis. It may be that external influences, such as changes in temperature or humidity, are enough to upset the balance between host and parasite or that a new microbial invader enters and, by competing for some element in the environment, forces the original parasite to react more violently with its host. The term lowered resistance, often used to describe conditions at the onset of infectious disease, is not specific and simply implies any change in the immune system of the host.

A microorganism's environment can be changed radically, of course. If antibiotics are administered, the body's commensal organisms can be killed, and other, less-innocuous organisms may take their place. In the mouth and throat, penicillin may eradicate pneumococci, streptococci, and other bacteria that are sensitive to the drug, while microorganisms that are insensitive, such as *Candida albicans*, may then proliferate and cause thrush (an inflammatory condition of the mouth and throat). In the intestinal tract, an antibiotic may kill most of the microorganisms that are normally present and allow dangerous organisms, such as *Pseudomonas aeruginosa*, to multiply and perhaps to invade the bloodstream and the tissues of the body. If an infectious agent—for example, *Salmonella*—reaches the intestinal tract, treatment with an antibiotic may have an effect that differs from what was intended. Instead of attacking and destroying the *salmonella*, it may kill the normal inhabitants of the bowel and allow the *salmonella* to flourish and persist in the absence of competition from other microorganisms.

Ecology of Infectious Diseases

Family Patterns: Humans are social animals. As a result, human social habits and circumstances influence the spread of infectious agents. Poorer families tend to live in more-crowded conditions, which facilitate the passage of disease-causing organisms from one person to another. This is true whether the germs pass through the air from one respiratory tract to another or whether they are bowel organisms that depend for their passage on close personal hand-to-mouth contact or on lapses of sanitation and hygiene. The composition of the family unit is also important. In families with infants and preschool children, infection spreads more readily, for children of this age are both more susceptible to infection and, because of their undeveloped hygiene habits, more likely to share their microbes with other family members. Because of this close and confined contact, infectious agents are spread more rapidly. Distinction must be made between disease and infection. The virus of poliomyelitis, for example, spreads easily in conditions of close contact (infection), but it usually causes no active disease. When it does cause active disease, it attacks older people much more severely than the young. Children in more-crowded homes, for example, are likely to be infected at an early age and, if illness results, it is usually mild. In less-crowded conditions, young children are exposed less often to infection; when they first encounter the virus at an older age, they tend to suffer more severely. The difference between infection and disease is seen even more rapidly in early childhood, when infection leads more often to immunity than to illness. Under high standards of hygiene, young children are exposed less frequently, and fewer develop immunity in early life, with the result that paralytic illness, a rarity under the former conditions, is seen frequently in older children and adults. The pattern of infection and disease, however, can be changed. In the case of the poliomyelitis virus, only immunization can abolish both infection and disease.

Population Density: Density of population does not of itself determine the ease with which infection spreads through a population. In New York City, with its many high-rise dwellings, the density of the population per square mile is much greater than in some of the world's older cities, but the hepatitis virus, for example, spreads much faster in the latter. A family in a New York City apartment may never see the inhabitants of most of the other apartments in the block, while neighbours in an ancient Asian city are in daily contact. In New York state, the incidence of infectious hepatitis has been shown to vary inversely with population density—to be lowest in New York City, higher in other urban areas of the state, and highest in rural areas. This pattern reflects the population's chances of contact and social habits, as well as its density.

Social Habits: The vampire bats of Brazil, which transmit paralytic rabies, bite cattle but not ranchers, presumably because ranchers are few but cattle are plentiful on the plains of Brazil. Bat-transmitted rabies, however, does occur in humans in Trinidad, where herdsmen sleep in shacks near their animals. The mechanism of infection is the same in Brazil and Trinidad, but the difference in social habits affects the incidence of the disease. During the early 20th century in Malta, goats were milked at the customers' doors, and a *Brucella* species in the milk caused a disease that was common enough to be called Malta fever. When the pasteurization of milk became compulsory, Malta fever almost disappeared from the island. (It continued to occur in rural areas where people still drank their milk raw and were in daily contact with their infected animals.) Important alterations in environment also occur when children in a

modern community first go to school. Colds, coughs, sore throats, and swollen neck glands can occur one after the other. In a nursery school, with young children whose hygiene habits are undeveloped, outbreaks of dysentery and other bowel infections may occur, and among children who take their midday meal at school, foodborne infection caused by a breakdown in hygiene can sweep through entire classes of students. These are dangers against which the children are protected to some extent at home but against which they have no defense when they move to the school environment. Changing food habits among the general population also affect the environment for humans and microbes. Meals served in restaurants, for example, offer a greater danger of food poisoning if the standard of hygiene for food preparation is flawed. The purchase and preparation of poultry—which is often heavily infected with Salmonella—present a particular danger. If chickens are bought fresh from a farm or shop and cooked in an oven at home, food poisoning from eating them is rare. If poultry is purchased while it is deep-frozen and then not fully thawed before it is cooked, there is a good chance that insufficient heat penetration will allow the Salmonella—which thrive in the cold—to survive in the meat's centre and infect the people who eat it.

Temperature and Humidity: At a social gathering, the human density per square yard may be much greater than in any home, and humidity and temperature may rise to levels uncomfortable for humans but ideal for microbes. Virus-containing droplets pass easily from one person to another, and an outbreak of the common cold may result. In contrast, members of scientific expeditions have spent whole winters in the Arctic or Antarctic without any respiratory illness, only to catch severe colds upon the arrival of a supply ship in the early summer. This is because viruses, not cold temperatures, cause colds. During polar expeditions, the members rapidly develop immunity to the viruses they bring with them, and, throughout the long winter, they encounter no new ones. Their colds in the summer are caused by viruses imported by the crew of the supply ship. When the members of the expedition return on the ship to temperate zones, they again come down with colds, this time caught from friends and relatives who have spent the winter at home.

Migration: Movement into a new environment often is followed by an outbreak of infectious disease. On pilgrimages and in wars, improvised feeding and sanitation lead to outbreaks of such intestinal infections as dysentery, cholera, and typhoid fever, and sometimes more have died in war from these diseases than have been killed in the fighting. People entering isolated communities may carry a disease such as measles with them, and the disease may then spread with astonishing rapidity and often with enhanced virulence. A traveler from Copenhagen carried measles virus with him to the Faroe Islands in 1846, and 6,000 of the 8,000 inhabitants caught the disease. Most of those who escaped were old enough to have acquired immunity during a measles outbreak 65 years earlier. In Fiji a disastrous epidemic of measles in 1875 killed one-fourth of the population. In these cases, the change of environment favoured the virus. Nearly every person in such "virgin" populations is susceptible to infection, so that a virus can multiply and spread unhindered. In a modern city population, by contrast, measles virus mainly affects susceptible young children. When it has run through them, the epidemic must die down because of a lack of susceptible people, and the virus does not spread again until a new generation of children is on hand. With the use of measles vaccine, the supply of susceptible young children is reduced, and the virus cannot spread and multiply and must die out. An innocent change in environment such as that experienced during camping can lead to infection if it brings a person into contact with sources of infection that are absent at home. Picnicking in a wood, a person may be bitten by a tick carrying the virus of one of several forms of encephalitis; as he swims in a canal or river, his skin may be penetrated by the organisms that cause leptospirosis. He may come upon some watercress growing wild in the damp corner of a field and may swallow with the cress almost invisible specks of life that will grow into liver flukes in his body, giving him fascioliasis, an illness that is common in cattle and sheep but that can spread to humans when circumstances are in its favour.

Occupation and Commerce: In occupational and commercial undertakings, people often manipulate their environment and, in so doing, expose themselves to infection. A farmer in his fields is exposed to damp conditions in which disease microorganisms flourish. While clearing out a ditch, he may be infected with leptospires passed into the water in rats' urine. In his barns he may be exposed to brucellosis if his

herd of cattle is infected or to salmonellosis or Q fever. Slaughterhouse workers run similar risks, as do veterinarians. A worker in a dock or tannery may get anthrax from imported hides; an upholsterer may get the disease from wool and hair; and a worker mending sacks that have contained bone meal may contract the disease from germs still clinging to the sack. Workers in packing plants and shops often are infected from the raw meat that they handle; they are sometimes regarded as carriers and causes of outbreaks of Salmonella food poisoning, but as often as not they are victims rather than causes. Workers in poultry plants can contract salmonellosis, more rarely psittacosis or a viral infection of the eye, from the birds that they handle. Forestry workers who enter a reserve may upset the balance of nature of the area and expose themselves to attack from the undergrowth or the trees by insect vectors of disease that, if undisturbed, would never come into contact with humans. Whenever people manipulate the environment—by herding animals, by importing goods from abroad, by draining a lake, or by laying a pipe through swampy land, and in many other seemingly innocent ways—they run the chance of interfering with microbial life and attracting into their own environment agents of disease that they might not otherwise ever encounter.

NUTRITIONAL DEFICIENCY RELATED DISEASES

The most significant nutrition-related disease is chronic undernutrition, which plagues more than 800 million people worldwide. Undernutrition is a condition in which there is insufficient food to meet energy needs; its main characteristics include weight loss, failure to thrive, and wasting of body fat and muscle. Low birth weight in infants, inadequate growth and development in children, diminished mental function, and increased susceptibility to disease are among the many consequences of chronic persistent hunger, which affects those living in poverty in both industrialized and developing countries. The largest number of chronically hungry people live in Asia, but the severity of hunger is greatest in sub-Saharan Africa. At the start of the 21st century, approximately 20,000 people, the majority of them children, died each day from undernutrition and related diseases that could have been prevented. The deaths of many of these children stem from the poor nutritional status of their mothers, as well as the lack of opportunity imposed by poverty.

Only a small percentage of hunger deaths is caused by starvation due to catastrophic food shortages. During the 1990s, for example, worldwide famine (epidemic failure of the food supply) more often resulted from complex social and political issues and the ravages of war than from natural disasters such as droughts and floods.

Malnutrition is the impaired function that results from a prolonged deficiency—or excess—of total energy or specific nutrients such as protein, essential fatty acids, vitamins, or minerals. This condition can result from fasting and anorexia nervosa; persistent vomiting (as in bulimia nervosa) or inability to swallow; impaired digestion and intestinal malabsorption; or chronic illnesses that result in loss of appetite (e.g., cancer, AIDS). Malnutrition can also result from limited food availability, unwise food choices, or overzealous use of dietary supplements. (See the table of select nutrient-deficiency diseases.)

Select nutrient-deficiency diseases		
disease (and key nutrient involved)	symptoms	foods rich in key nutrient
1 xerophthalmia (vitamin A)	blindness from chronic eye infections, poor growth, dryness and keratinization of epithelial tissues	liver, fortified milk, sweet potatoes, spinach, greens, carrots, cantaloupe, apricots
2 rickets (vitamin D)	weakened bones, bowed legs, other bone deformities	fortified milk, fish oils, sun exposure
3 beriberi (vitamin B ₁)	nerve degeneration, altered muscle coordination, cardiovascular problems	pork, whole and enriched grains, dried beans, sunflower seeds
4 pellagra (niacin)	3Ds diarrhea, skin inflammation, dementia (dermatitis)	mushrooms, bran, tuna, chicken, beef, peanuts, whole and enriched grains
5 scurvy (vitamin C)	delayed wound healing, internal bleeding, abnormal formation of bones and teeth	citrus fruits, strawberries, broccoli
6 iron-deficiency anemia (iron)	decreased work output, reduced growth, increased health risk in pregnancy	meat, spinach, seafood, broccoli, peas, bran, whole-grain and enriched breads
7 goitre (iodine)	enlarged thyroid gland, poor growth in infancy and childhood, possible mental retardation, cretinism	iodized salt, saltwater fish

Source: Gordon M. Wardlaw, *Perspectives in Nutrition* (1999).

PROTEIN ENERGY MALNUTRITION

Chronic undernutrition manifests primarily as protein-energy malnutrition (PEM), which is the most common form of malnutrition worldwide. Also known as protein-calorie malnutrition, PEM is a continuum in which people—all too often children—consume too little protein, energy, or both. At one end of the continuum is kwashiorkor, characterized by a severe protein deficiency, and at the other is marasmus, an absolute food deprivation with grossly inadequate amounts of both energy and protein.

An infant with marasmus is extremely underweight and has lost most or all subcutaneous fat. The body has a "skin and bones" appearance, and the child is profoundly weak and highly susceptible to infections. The cause is a diet very low in calories from all sources (including protein), often from early weaning to a bottled formula prepared with unsafe water and diluted because of poverty. Poor hygiene and continued depletion lead to a vicious cycle of gastroenteritis and deterioration of the lining of the gastrointestinal tract, which interferes with absorption of nutrients from the little food available and further reduces resistance to infection. If untreated, marasmus may result in death due to starvation or heart failure.

Kwashiorkor, a Ghanaian word meaning the disease that the first child gets when the new child comes, is typically seen when a child is weaned from high-protein breast milk onto a carbohydrate food source with insufficient protein. Children with this disease, which is characterized by a swollen belly due to edema (fluid retention), are weak, grow poorly, and are more susceptible to infectious diseases, which may result in fatal diarrhea. Other symptoms of kwashiorkor include apathy, hair discoloration, and dry,

peeling skin with sores that fail to heal. Weight loss may be disguised because of the presence of edema, enlarged fatty liver, and intestinal parasites; moreover, there may be little wasting of muscle and body fat.

- ✓ Kwashiorkor and marasmus can also occur in hospitalized patients receiving intravenous glucose for an extended time, as when recovering from surgery, or in those with illnesses causing loss of appetite or malabsorption of nutrients. Persons with eating disorders, cancer, AIDS, and other illnesses where appetite fails or absorption of nutrients is hampered may lose muscle and organ tissue as well as fat stores.

Treatment of PEM has three components. (1) Life-threatening conditions—such as fluid and electrolyte imbalances and infections—must be resolved. (2) Nutritional status should be restored as quickly and safely as possible; rapid weight gain can occur in a starving child within one or two weeks. (3) The focus of treatment then shifts to ensuring nutritional rehabilitation for the long term. The speed and ultimate success of recovery depend upon the severity of malnutrition, the timeliness of treatment, and the adequacy of ongoing support. Particularly during the first year of life, starvation may result in reduced brain growth and intellectual functioning that cannot be fully restored.

CARBOHYDRATES

Under most circumstances, there is no absolute dietary requirement for carbohydrates—simple sugars, complex carbohydrates such as starches, and the indigestible plant carbohydrates known as dietary fibre. Certain cells, such as brain cells, require the simple carbohydrate glucose as fuel. If dietary carbohydrate is insufficient, glucose synthesis depends on the breakdown of amino acids derived from body protein and dietary protein and the compound glycerol, which is derived from fat. Long-term carbohydrate inadequacy results in increased production of organic compounds called ketones (a condition known as ketosis), which imparts a distinctive sweet odour to the breath. Ketosis and other untoward effects of a very-low-carbohydrate diet can be prevented by the daily consumption of 50 to 100 grams of carbohydrate; however, obtaining at least half of the daily energy intake from carbohydrates is recommended and is typical of human diets, corresponding to at least 250 grams of carbohydrate (1,000 calories in a 2,000-calorie diet). A varied diet containing fruits, vegetables, legumes, and whole-grain cereals, which are all abundant in carbohydrates, also provides a desirable intake of dietary fibre.

ESSENTIAL FATTY ACIDS

There is also a minimum requirement for fat—not for total fat, but only for the fatty acids linoleic acid (a so-called omega-6 fatty acid) and alpha-linolenic acid (an omega-3 fatty acid). Deficiencies of these two fatty acids have been seen in hospitalized patients fed exclusively with intravenous fluids containing no fat for weeks, patients with medical conditions affecting fat absorption, infants given formulas low in fat, and young children fed nonfat milk or low-fat diets. Symptoms of deficiency include dry skin, hair loss, and impaired wound healing. Essential fatty acid requirements—a few grams a day—can be met by consuming approximately a tablespoon of polyunsaturated plant oils daily. Fatty fish also provides a rich source of omega-3 fatty acids. Even individuals following a low-fat diet generally consume sufficient fat to meet requirements.

VITAMINS

Although deficiency diseases have been described in laboratory animals and humans deprived of single vitamins, in human experience multiple deficiencies are usually present simultaneously. The eight B-complex vitamins function in coordination in numerous enzyme systems and metabolic pathways; thus, a deficiency of one may affect the functioning of others.

- ✓ Vitamin A: Vitamin A deficiency is the leading cause of preventable blindness in children and is a major problem in the developing world, especially in Africa and Southeast Asia; in the poorest countries hundreds of thousands of children become blind each year due to a deficiency of the vitamin. Even a mild deficiency can impair immune function, thereby reducing resistance to disease. Night blindness is an

Anthropology Paper 01 - Volume 01

early sign of vitamin A deficiency, followed by abnormal dryness of the eye and ultimately scarring of the cornea, a condition known as xerophthalmia. Other symptoms include dry skin, hardening of epithelial cells elsewhere in the body (such as mucous membranes), and impaired growth and development. In many areas where vitamin A deficiency is endemic, the incidence is being reduced by giving children a single large dose of vitamin A every six months. A genetically modified form of rice containing beta-carotene, a precursor of vitamin A, has the potential to reduce greatly the incidence of vitamin A deficiency, but the use of this so-called golden rice is controversial. (Golden Rice)

Vitamin D: Vitamin D (also known as vitamin D hormone) is synthesized in the body in a series of steps, starting in the skin by the action of sunlight's ultraviolet rays on a precursor compound; thus, without adequate food sources of vitamin D, a deficiency of the vitamin can occur when exposure to sunlight is limited. Lack of vitamin D in children causes rickets, a disease characterized by inadequate mineralization of bone, growth retardation, and skeletal deformities such as bowed legs. The adult form of rickets, known as osteomalacia, results in weak muscles as well as weak bones. Inadequate vitamin D may also contribute to the thinning of bones seen in osteoporosis. Individuals with limited sun exposure (including women who completely cover their bodies for religious reasons), elderly or homebound persons, and those with dark skin, particularly those who live in northern latitudes, are at risk of vitamin D deficiency. Vitamin D is found in very few foods naturally; thus fortification of milk and other foods (e.g., margarine, cereals, and breads) with the vitamin has helped protect those populations in which sun exposure is inadequate. Supplemental vitamin D also may help protect against bone fractures in the elderly, who make and activate vitamin D less efficiently even if exposed to sunlight.

Vitamin E: Vitamin E deficiency is rare in humans, although it may develop in premature infants and in people with impaired fat absorption or metabolism. In the former, fragility of red blood cells (hemolysis) is seen; in the latter, where deficiency is more prolonged, neuromuscular dysfunction involving the spinal cord and retina may result in loss of reflexes, impaired balance and coordination, muscle weakness, and visual disturbances. No specific metabolic function has been established for vitamin E; however, it is an important part of the antioxidant system that inhibits lipid peroxidation; i.e., it protects cells and their membranes against the damaging effects of free radicals (reactive oxygen and nitrogen species) that are produced metabolically or enter the body from the environment. The requirement for vitamin E is increased with increasing consumption of polyunsaturated fatty acids. People who smoke or are subjected to air pollution may also need more of the vitamin to protect against oxidative damage to the lungs.

Vitamin K: Vitamin K is necessary for the formation of prothrombin and other blood-clotting factors in the liver, and it also plays a role in bone metabolism. A form of the vitamin is produced by bacteria in the colon and can be utilized to some degree. Vitamin K deficiency causes impaired clotting of the blood and internal bleeding, even without injury. Due to poor transport of vitamin K across the placenta, newborn infants in developed countries are routinely given the vitamin intramuscularly or orally within six hours of birth to protect against a condition known as hemorrhagic disease of the newborn. Vitamin K deficiency is rare in adults, except in syndromes with poor fat absorption, in liver disease, or during treatment with certain anticoagulant drugs, which interfere with vitamin K metabolism. Bleeding due to vitamin K deficiency may be seen in patients whose gut bacteria have been killed by antibiotics.

Thiamin: Prolonged deficiency of thiamin (vitamin B₁) results in beriberi, a disease that has been endemic in populations where white rice has been the staple. Thiamin deficiency is still seen in areas where white rice or flour constitutes the bulk of the diet and thiamin lost in milling is not replaced through enrichment. Symptoms of the form known as dry beriberi include loss of appetite, confusion and other mental symptoms, muscle weakness, painful calf muscles, poor coordination, tingling and paralysis. In wet beriberi there is edema and the possibility of an enlarged heart and heart failure. Thiamin deficiency can also occur in populations eating large quantities of raw fish harbouring intestinal microbes that contain the enzyme thiaminase. In the developed world, thiamin deficiency is linked primarily to chronic alcoholism with poor diet, manifesting as Wernicke-Korsakoff syndrome, a condition with rapid eye movements, loss of muscle coordination, mental confusion, and memory loss.

Riboflavin: Riboflavin (vitamin B₂) deficiency, known as riboflavinosis, is unlikely without the simultaneous deficiency of other nutrients. After several months of riboflavin deprivation, symptoms include cracks in the skin at the corners of the mouth, fissures of the lips, and an inflamed, magenta-coloured tongue. Because riboflavin is readily destroyed by ultraviolet light, jaundiced infants who are treated with light therapy are administered the vitamin. Milk, milk products, and cereals, major sources of riboflavin in the diet, are packaged to prevent exposure to light.

Niacin: Symptoms of pellagra develop about two months after niacin is withdrawn from the diet. Pellagra is characterized by the so-called three Ds—diarrhea, dermatitis, and dementia—and, if it is allowed to progress untreated, death ensues. Pellagra was common in areas of the southern United States in the early 1900s and still occurs in parts of India, China, and Africa, affecting people who subsist primarily on corn. The niacin in corn and other cereal grains is largely in bound form, unable to be absorbed well. Soaking corn in lime water, as practiced by Native American populations for centuries, frees bound niacin and thus protects against pellagra. In addition, unlike other cereals, corn is low in the amino acid tryptophan, which can be converted in part to niacin. Sufficient high-quality protein (containing tryptophan) in the diet can protect against niacin deficiency even if intake of niacin itself is inadequate.

Vitamin B₆: Vitamin B₆ (pyridoxine and related compounds) is essential in protein metabolism, the synthesis of neurotransmitters, and other critical functions in the body. Deficiency symptoms include dermatitis, microcytic hypochromic anemia (small, pale red blood cells), impaired immune function, depression, confusion, and convulsions. Although full-blown vitamin B₆ deficiency is rare, marginal inadequacy is more widespread, especially among the elderly, who may have a reduced ability to absorb the vitamin. People with alcoholism, especially those with the liver diseases cirrhosis and hepatitis, are at risk of deficiency. A number of drugs, including the tuberculosis drug isoniazid, interfere with vitamin B₆ metabolism.

Folic acid: Vitamin B₁₂ and folic acid (folate) are two B vitamins with many closely related functions, notably participation in DNA synthesis. As a result, people with deficiencies of either vitamin show many of the same symptoms, such as weakness and fatigue due to megaloblastic anemia, a condition in which red blood cells, lacking sufficient DNA for cell division, are large and immature. Deficiency of folic acid also causes disruption of cell division along the gastrointestinal tract, which results in persistent diarrhea, and impaired synthesis of white blood cells and platelets. Inadequate intake of the vitamin in early pregnancy may cause neural tube defects in the fetus. Thus, women capable of becoming pregnant are advised to take 400 micrograms (μg) of folic acid daily from supplements, fortified foods (such as fortified cereals), or both—in addition to consuming foods rich in folic acid such as fresh fruits and vegetables (especially leafy greens) and legumes. The cancer drug methotrexate interferes with folic acid metabolism, causing side effects such as hair loss and diarrhea. Folic acid deficiency may also result from heavy use of alcohol, which interferes with absorption of the vitamin.

Vitamin B₁₂: Deficiency of vitamin B₁₂ (cobalamin), like folic acid, results in megaloblastic anemia (large, immature red blood cells), due to interference with normal DNA synthesis. Additionally, vitamin B₁₂ maintains the myelin sheath that protects nerve fibres; therefore, an untreated deficiency of the vitamin can result in nerve degeneration and eventually paralysis. Large amounts of folic acid (over 1,000 μg per day) may conceal, and possibly even exacerbate, an underlying vitamin B₁₂ deficiency. Only animal foods are reliable sources of vitamin B₁₂. Vegans, who eat no foods of animal origin, are at risk of vitamin B₁₂ deficiency and must obtain the vitamin through fortified food or a supplement. For people who regularly eat animal products, deficiency of the vitamin is unlikely, unless there is a defect in absorption. In order to be absorbed, vitamin B₁₂ must be bound to intrinsic factor, a substance secreted by the stomach. If intrinsic factor is absent (due to an autoimmune disorder known as pernicious anemia) or if there is insufficient production of hydrochloric acid by the stomach, absorption of the vitamin will be limited. Pernicious anemia, which occurs most often in the elderly, can be treated by injections or massive oral doses (1,000 μg) of vitamin B₁₂.

Anthropology Paper 01 - Volume 01

Pantothenic acid: Pantothenic acid is so widespread in foods that deficiency is unlikely under normal circumstances. Deficiency has been seen only in individuals fed semisynthetic diets deficient in the vitamin or in subjects given a pantothenic acid antagonist. Symptoms of deficiency include fatigue, irritability, sleep disturbances, abdominal distress, and neurological symptoms such as tingling in the hands. Deficiency of the vitamin was suspected during World War II when prisoners of war in Asia who exhibited "burning feet" syndrome, characterized by numbness and tingling in the toes and other neurological symptoms, responded only to the administration of pantothenic acid.

Biotin: Deficiency of biotin is rare, and this may be due in part to synthesis of the vitamin by bacteria in the colon, although the importance of this source is unclear. Biotin deficiency has been observed in people who regularly eat large quantities of raw egg white, which contains a glycoprotein (avidin) that binds biotin and prevents its absorption. A rare genetic defect that renders some infants unable to absorb a form of biotin in food can be treated with a supplement of the vitamin. Long-term use of certain anticonvulsant drugs may also impair biotin absorption. Symptoms of deficiency include skin rash, hair loss, and eventually neurological abnormalities.

Vitamin C: Vitamin C, also known as ascorbic acid, functions as a water-soluble antioxidant and as a cofactor in various enzyme systems, such as those involved in the synthesis of connective tissue components and neurotransmitters. Symptoms of scurvy, a disease caused by vitamin C deficiency, include pinpoint hemorrhages (petechiae) under the skin, bleeding gums, joint pain, and impaired wound healing. Although rare in developed countries, scurvy is seen occasionally in people consuming restricted diets, particularly those containing few fruits and vegetables, or in infants fed boiled cow's milk and no source of vitamin C. Scurvy can be prevented with relatively small quantities of vitamin C (10 milligrams [mg] per day), although recommended intakes, which aim to provide sufficient antioxidant protection, are closer to 100 mg per day. Disease states, environmental toxins, drugs, and other stresses can increase an individual's vitamin C needs. Smokers, for example, may require an additional 35 mg of the vitamin daily to maintain vitamin C levels comparable to nonsmokers.

IRON

- ✓ Iron deficiency is the most common of all nutritional deficiencies, with much of the world's population being deficient in the mineral to some degree. Young children and premenopausal women are the most vulnerable. The main function of iron is in the formation of hemoglobin, the red pigment of the blood that carries oxygen from the lungs to other tissues. Since each millilitre of blood contains 0.5 mg of iron (as a component of hemoglobin), bleeding can drain the body's iron reserves. When iron stores are depleted a condition arises known as microcytic hypochromic anemia, characterized by small red blood cells that contain less hemoglobin than normal. Symptoms of severe iron deficiency anemia include fatigue, weakness, apathy, pale skin, difficulty breathing on exertion, and low resistance to cold temperatures.
- ✓ During childhood, iron deficiency can affect behaviour and learning ability as well as growth and development. Severe anemia increases the risk of pregnancy complications and maternal death. Iron deficiency anemia is most common during late infancy and early childhood, when iron stores present from birth are exhausted and milk, which is poor in iron, is a primary food; during the adolescent growth spurt; and in women during the childbearing years, because of blood loss during menstruation and the additional iron needs of pregnancy. Intestinal blood loss and subsequent iron deficiency anemia in adults may also stem from ulcers, hemorrhoids, tumors, or chronic use of certain drugs such as aspirin. In developing countries, blood loss due to hookworm and other infections, coupled with inadequate dietary iron intake, exacerbates iron deficiency in both children and adults.

IODINE

- ✓ Iodine deficiency disorders are the most common cause of preventable brain damage, which affects an estimated 50 million people worldwide. During pregnancy, severe iodine deficiency may impair fetal development, resulting in cretinism (irreversible mental retardation with short stature and developmental abnormalities) as well as in miscarriage and stillbirth. Other more pervasive

consequences of chronic iodine deficiency include lesser cognitive and neuromuscular deficits. The ocean is a dependable source of iodine, but away from coastal areas iodine in food is variable and largely reflects the amount in the soil. In chronic iodine deficiency the thyroid gland enlarges as it attempts to trap more iodide (the form in which iodine functions in the body) from the blood for synthesis of thyroid hormones, and it eventually becomes a visible lump at the front of the neck known as a goitre. Some foods, such as cassava, millet, sweet potato, certain beans, and members of the cabbage family, contain substances known as goitrogens that interfere with thyroid hormone synthesis; these substances, which are destroyed by cooking, can be a significant factor in persons with coexisting iodine deficiency who rely on goitrogenic foods as staples. Since a strategy of universal iodization of salt was adopted in 1993, there has been remarkable progress in improving iodine status worldwide. Nonetheless, millions of people living in iodine-deficient areas, primarily in Central Africa, Southeast and Central Asia, and even in central and eastern Europe, remain at risk.

ZINC

A constituent of numerous enzymes, zinc plays a structural role in proteins and regulates gene expression. Zinc deficiency in humans was first reported in the 1960s in Egypt and Iran, where children and adolescent boys with stunted growth and undeveloped genitalia responded to treatment with zinc. Deficiency of the mineral was attributed to the regional diet, which was low in meat and high in legumes, unleavened breads, and whole-grain foods that contain fibre, phytic acid, and other factors that inhibit zinc absorption. Also contributing to zinc deficiency was the practice of clay eating, which interferes with the absorption of zinc, iron, and other minerals. Severe zinc deficiency has also been described in patients fed intravenous solutions inadequate in zinc and in the inherited zinc-responsive syndrome known as acrodermatitis enteropathica. Symptoms of zinc deficiency may include skin lesions, diarrhea, increased susceptibility to infections, night blindness, reduced taste and smell acuity, poor appetite, hair loss, slow wound healing, low sperm count, and impotence. Zinc is highest in protein-rich foods, especially red meat and shellfish, and zinc status may be low in protein-energy malnutrition. Even in developed countries, young children, pregnant women, the elderly, strict vegetarians, people with alcoholism, and those with malabsorption syndromes are vulnerable to zinc deficiency.

CALCIUM

Almost all the calcium in the body is in the bones and teeth, the skeleton serving as a reservoir for calcium needed in the blood and elsewhere. During childhood and adolescence, adequate calcium intake is critical for bone growth and calcification. A low calcium intake during childhood, and especially during the adolescent growth spurt, may predispose one to osteoporosis, a disease characterized by reduced bone mass, later in life. As bones lose density, they become fragile and unable to withstand ordinary strains; the resulting fractures, particularly of the hip, may cause incapacitation and even death. Osteoporosis is particularly common in postmenopausal women in industrial societies. Not a calcium-deficiency disease per se, osteoporosis is strongly influenced by heredity; risk of the disease can be lessened by ensuring adequate calcium intake throughout life and engaging in regular weight-bearing exercise. Sufficient calcium intake in the immediate postmenopausal years does appear to slow bone loss, although not to the same extent as do bone-conserving drugs.

FLUORIDE

Fluoride also contributes to the mineralization of bones and teeth and protects against tooth decay. Epidemiological studies in the United States in the 1930s and 1940s revealed an inverse relationship between the natural fluoride content of waters and the rate of dental caries. In areas where fluoride levels in the drinking water are low, prescription fluoride supplements are recommended for children older than six months of age; dentists also may apply fluoride rinses or gels periodically to their patients' teeth. Fluoridated toothpastes are an important source of fluoride for children and also for adults, who continue to benefit from fluoride intake.

SODIUM

Sodium is usually provided in ample amounts by food, even without added table salt (sodium chloride). Furthermore, the body's sodium-conservation mechanisms are highly developed, and thus sodium deficiency is rare, even for those on low-sodium diets. Sodium depletion may occur during prolonged heavy sweating, vomiting, or diarrhea or in the case of kidney disease. Symptoms of hyponatremia, or low blood sodium, include muscle cramps, nausea, dizziness, weakness, and eventually shock and coma. After prolonged high-intensity exertion in the heat, sodium balance can be restored by drinking beverages containing sodium and glucose (so-called sports drinks) and by eating salted food. Drinking a litre of water containing two millilitres (one-third teaspoon) of table salt also should suffice.

Chloride is lost from the body under conditions that parallel those of sodium loss. Severe chloride depletion results in a condition known as metabolic alkalosis (excess alkalinity in body fluids).

POTASSIUM

Potassium is widely distributed in foods and is rarely deficient in the diet. However, some diuretics used in the treatment of hypertension deplete potassium. The mineral is also lost during sustained vomiting or diarrhea or with chronic use of laxatives. Symptoms of potassium deficiency include weakness, loss of appetite, muscle cramps, and confusion. Severe hypokalemia (low blood potassium) may result in cardiac arrhythmias. Potassium-rich foods, such as bananas or oranges, can help replace losses of the mineral, as can potassium chloride supplements, which should be taken only under medical supervision.

WATER DEFICIENCY - DEHYDRATION

Water is the largest component of the body, accounting for more than half of body weight. To replace fluid losses, adults generally need to consume 2 to 4 litres of fluid daily in cool climates, depending on degree of activity, and from 8 to 16 litres a day in very hot climates. Dehydration may develop if water consumption fails to satisfy thirst; if the thirst mechanism is not functioning properly, as during intense physical exercise; or if there is excessive fluid loss, as with diarrhea or vomiting. By the time thirst is apparent, there is already some degree of dehydration, which is defined as loss of fluid amounting to at least 1 to 2 percent of body weight. Symptoms can progress quickly if not corrected: dry mouth, sunken eyes, poor skin turgor, cold hands and feet, weak and rapid pulse, rapid and shallow breathing, confusion, exhaustion, and coma. Loss of fluid constituting more than 10 percent of body weight may be fatal. The elderly (whose thirst sensation may be dulled), people who are ill, and those flying in airplanes are especially vulnerable to dehydration. Infants and children with chronic undernutrition who develop gastroenteritis may become severely dehydrated from diarrhea or vomiting. Treatment is with an intravenous or oral solution of glucose and salts.

10. CONCEPT OF HUMAN GROWTH AND DEVELOPMENT

CONCEPT OF HUMAN GROWTH AND DEVELOPMENT

In day to day parlance the terms "growth" and "development" are used interchangeably. However, the two terms are conceptually different, though both denote the dynamic aspects of life process. The dynamic aspect of life process starts with the union of sperm and egg. The zygote thus formed after fertilization undergoes a series of changes which include the multiplication of cells, the expansion of the cells, structural and functional differentiation of the cells, maturation and acquisition of a variety of new functions. A close look at these various aspects of life process includes both quantitative and qualitative changes. The quantitative change constitutes growth and the qualitative change constitutes development.

- ✓ 1 The term "growth" denotes the net increase in the size of tissues and the multiplication of the cells. It also includes the expansion in the size of cells. On the other hand, the term "development" includes processes involving functional specialization, acquisition of a variety of skills, process of maturation, etc. Like the emergence of a butterfly from a cocoon, qualitative change is marked by the appearance of new phenomena that could not have been predicted from earlier functioning. Speech is one such phenomenon.

Human development is the scientific study of how people change and how they stay the same over time. In some ways, people show an underlying continuity or consistency, from one time of life to another. In other ways they change. This study basically focuses on an analysis of the following:

- i) How people change throughout life?
- ii) What people need to develop normally?
- iii) How people react to the many influences upon and within them?
- iv) How people can best fulfill their potential as individuals and as species?

The study of human development draws on many disciplines, including psychology, sociology, anthropology, biology, education and medicine.

Aspects of Growth and Development: Human development is a complex phenomenon. One reason for such complexity is that growth and development occur in different aspects of the self. There are three aspects of Growth and Development - physical, intellectual and, personality and social. Each aspect of development affects the other.

- a 1. **Physical Development:** Changes in the body, the brain, sensory capacities are all part of physical development. They exert a major influence on the intellect and personality.
- b 2. **Intellectual Development:** Changes in the mental abilities - such as learning, memory, reasoning, thinking and language - are aspects of intelligence development. These changes are closely related to motor and emotional development.
- c 3. **Personality and Social Development:** Personality - the unique way in which each person deals with the world, expresses emotions, and so on and social development - relationship with others - affect both the cognitive aspects and the physical aspects of functioning.

Individual Differences in Growth and Development: Although people typically proceed through the same general sequence of development, there is a wide range of individual differences in the timing and expression of developmental changes. The range of individual differences increases as people grow older. Normal children pass the same milestones in development at nearly the same ages. Later in life, experiences and environment exert more influence.

Anthropology Paper 01 - Volume 01

Not only rates, but also the results of development vary. People differ in height, weight and body build, in health and energy levels, in comprehension of complex ideas, and in emotional reactions.

Influences on Development: Development and Growth are subject to many influences. Some influences are purely individual and others are common to an entire group. People's own behavior and life style also influence their development. All these factors are discussed in detail later in this chapter.

Influences on development can be both internal and external. Internal influences on development originate with heredity - the inborn genetic endowment that people receive from their parents. External influences, or environmental influences, come from people's experiences with the world outside the self.

Rate of Growth: Rate of growth is also called growth velocity and it can be defined as the increment in growth at a period of time. Measurement of growth velocity helps in early assessment of retarding factors of growth and also the prediction of ultimate growth.

Catch-up Growth: It is also called as compensatory growth. After illness or starvation, which is a period characterized by slow growth, there has been found a tendency in the young subjects to bridge the deficit as soon as possible and catch-up with the original growth curve. This is known as catch-up growth.

Catch-up growth may be complete or incomplete. It depends on the severity of the stress and the period of stress.

Principles of Growth: Growth and Development are not haphazard or idiosyncratic. Rather, it progresses along logical lines that are similar for all human beings. Three guiding principles are at work in growth and development both before and after birth.

1. **Top-to-Bottom Development:** This principle, also called the Cephalocaudal principle ("head to tail", from Greek and Latin roots), dictates that development proceeds from the head to the lower parts of the body. An embryo's head, brain and eyes develop first; the head of a two month old embryo is half the length of the entire body. By the time of birth, the head is only one-fourth the length of the body but is still disproportionately large; it becomes less so as the child grows. Further more, infants learn to use the upper parts of the body before the lower parts. Babies can see objects before they can control the trunk, and they can use their hands to grasp long before they can walk.
2. **Inner-to-Outer Development:** According to this principle, which is also called Proximodistal principle ("near to far", from Latin roots), development proceeds from the central part of the body to outer parts. The embryonic trunk and head develop before the limbs, and the arms and legs before the fingers and toes. Babies first develop the ability to use their upper arms and upper legs (which are closest to central axis), then their forearms and forelegs, then their hands and feet, and finally their fingers and toes.
3. **Simple-to-Complex Development:** The third rule of development states that in acquiring all practical skills, we progress from the simple to the complex. Children could sit with support before they can sit alone.

Some gerontologists distinguish between primary ageing - a gradual, inevitable process of bodily deterioration that begins early in life and continues through the years; and secondary ageing - the results of disease, abuse and disuse - factors that are often avoidable and under people's control. Older people may not be able to stop their reflexes from slowing down or their hearing from becoming less acute; but by eating sensibly and keeping physically fit; many can and do stop the secondary effects of ageing.

STAGES OF HUMAN GROWTH

PRENATAL DEVELOPMENT

Prenatal development proceeds according to genetic instructions from a single cell to an extremely complex being. This development before birth is called Gestation. It takes place in three stages: Germinal, Embryonic and Fetal. Some highlights of each stage are discussed.

1. **Germinal Stage (Fertilization to 2 Weeks):** During the Germinal Stage, the organism divides, becomes more complex, and is implanted in the wall of the Uterus. Within 36 hours of fertilization, the single cell zygote enters a period of rapid cell division. After 72 hours of fertilization, it has divided into 64 cells. This cell division continues until the original cell has become 800 billion or more cells that make up the adult human body.

While the fertilized egg is dividing, it is also making its way down the fallopian tube to the uterus, a journey of 3 or 4 days. Meanwhile, its form has changed to a fluid filled sphere, a blastocyst, which then floats freely in the uterus for a day or two. Some cells around the edge of the blastocyst cluster on one side to form the embryonic disk, a thickened cell mass from which the baby will develop. This mass is already differentiating into two layers. The upper layer, the ectoderm, will become the nails, hair, teeth, sensory organs, the outer layer of skin, and the nervous system, including the brain and the spinal cord. The lower layer, the endoderm, will develop into the digestive system, liver, pancreas, salivary glands, and respiratory system. Later, a middle layer, the mesoderm, will develop and differentiate into the inner layer of skin, muscles, skeleton, and excretory and circulatory system.

During the germinal stage, other parts of the blastocyst develop into the nurturing and protective organs; the placenta, the umbilical cord, the amniotic sac. The placenta, which has several important functions, is connected to the embryo by the umbilical cord, through which it delivers oxygen and nourishment to the embryo and removes its body wastes. The placenta also helps to combat internal infection and protects the unborn child from various diseases. It produces the hormones that support pregnancy, prepare the mother's breasts for lactation, and eventually stimulate the uterine contractions that will expel the baby from her body. The amniotic sac, a fluid filled membrane, encases the baby, protecting it and giving it room to move.

The Trophoblast, the outer cell layer of the blastocyst, produces tiny threadlike structures that penetrate the lining of the uterine wall. In this way, the blastocyst burrows into the wall of the uterus until it is implanted in a nesting place where it will receive nourishment from the mother's body. Upon implantation, the blastocyst has about 150 cells; when it is fully implanted in the uterus, it is an embryo.

2. **Embryonic Stage (2 to 8-12 Weeks):** During the embryonic stage - the second stage of gestation - the major body systems (respiratory, alimentary, and nervous) and organs develop. ✓
Because of its rapid growth and development, the embryo is very vulnerable to environmental influences. Almost all the developmental birth defects occur during the critical first three month period, or trimester of pregnancy.
3. **Fetal Stage (8-12 Weeks to Birth) :** With the appearance of the first bone cells at about 8 weeks, the embryo begins to become a fetus, and by 12 weeks it is fully in the fetal stage, the final stage of gestation. From now until birth, the finishing touches are put on the various body parts and the body changes in form and eventually grows about 20 times in length.

The fetus is far from being a passive passenger in its mother's womb. It kicks, turns, flexes its body, somersaults, swallows, hiccups and sucks its thumb. It responds to both sound and vibrations, showing that it can hear and feel.

Anthropology Paper 01 - Volume 01

Even within the womb, each of us is unique. Fetuses' activity varies in amount and kind, and their heart rates vary in regularity and speed. Some of these patterns persist to adulthood, supporting the notion of "inborn temperament".

Birth: Birth is both a beginning and an end; the climax of all that has happened from the moment of fertilization through nine months of growth in the womb. The uterine contractions that expel the fetus begin as mild tightening of the uterus, each lasting 15 to 25 seconds.

Stages of Child Birth:

Child birth, or labor, takes place in three overlapping stages. The first stage, which is the longest, lasts an average of 12 to 24 hours for a woman having her first child. During this stage, uterine contractions cause the cervix to widen until it becomes large enough for the baby's head to pass through, a process called dilation. At the beginning of this stage, the contractions occur about every 8 to 10 minutes and last 30 seconds. Toward the end of the labor they may come every 2 minutes and last 60 to 90 seconds.

The second stage, which typically lasts about one and a half hour begins when the baby's head begins to move through the cervix into the vaginal canal, and it ends when the baby emerges completely from the mother's body. At the end of this stage the baby is born. The umbilical cord, which is still attached to the placenta, is cut and clamped.

During the third stage, which lasts only a few minutes, what is left of the umbilical cord and the placenta are expelled.

With the birth of the child, the prenatal stage of development is complete. This is followed by stage of infancy.

INFANCY

The time between birth to an age of 1 year falls under the stage of Infancy.

The Neonate: The first four weeks of life are the neonatal period, a time of transition from intrauterine life - when a fetus is supported by a mother's body - to an independent existence.

Physical Characteristics: An average neonate, or newborn, is about 20 inches long and weighs about 7 1/2 pounds. The size at birth is related to such factors as race, sex, maternal nutrition etc.

In their first few days, neonate loses as much as 10% of their body weight, primarily because of a loss of fluids. They begin to gain weight again at about the fifth day and are generally back to birth weight by the tenth to the fourteenth day.

The neonate's head may be long and misshapen because of "molding" that eased its passage through the mother's pelvis. This temporary molding was possible because the body's skull bones are not yet fused; they will not be completely joined for 18 months.

Newborns are quite pale and have a pinkish cast because of the thinness of skin; this barely covers the blood flowing through their capillaries.

Circulatory System: Before birth, mother and baby have independent circulatory systems and separate heartbeats; but the fetus's blood is cleansed through the umbilical cord, which carries blood to and from placenta. At birth, the baby's own system must take over. The neonate's heartbeat is still fast and irregular, and blood pressure does not stabilize until about the 10th day.

Respiratory System: The fetus gets oxygen through the umbilical cord, which also carries away carbon dioxide. The newborn, which needs much more oxygen, must now get it independently. Most infants start to breathe as soon as they emerge into the air.

Gastrointestinal System: The fetus relies on the umbilical cord to bring food and carry body wastes away. The newborn has a strong suckling reflex to take in milk and has gastrointestinal secretions to digest it.

Temperature Regulation: The layers of fat that develop during the last months of fetal life enable healthy full term infants to keep their body temperature constant despite changes in air temperature. They also maintain body temperature by increasing the activity.

Growth: Growth is faster during the first three years and especially during the first few months - than it even will be again. Children's early physical growth and muscular development make possible the rapid reflex/motor advancements of this period.

At five months, the typical baby's birth weight doubles. By one year, babies weigh three times their birth weight. During the second year, this rapid growth tapers off; the child gains 5 or 6 pounds and by the second birthday weighs about four times his or her birth weight. During the third year, the gain is even less about 4 to 5 pounds.

The same pattern holds true for height, which increases by about 10-12 inches during the first year, making the typical one year old about 30 inches tall. The average 2 year old has grown about 6 inches and is 3 feet tall; another 3 to 4 inches will be added in the third year.

As young children grow in size, their shape also changes. The rest of the body catches up with the head, which becomes proportionately smaller until full adult height become leaner; the 3 year old is slender.

Teething usually begins around 3 or 4 months, but the first tooth may not arrive until sometime between 5 and 9 months of age, by age 2 1/2, they have a mouthful - 20.

Motor Control: The eye coordination starts developing between 2-4 weeks and by 3-4 months; infants follow the objects with steady movement of eyes.

Hand to mouth coordination develops slightly later; the baby is able to feed himself only after 18 months. Hard skills begin to develop from 2 years when he could perform crude skills.

The infants learn to control body in the sitting position from age of 5 months. From the age of 9 months, the infant makes early stepping movements.

Language development starts by one month, when the infant attends to curious sounds. By nine months he produces monosyllable sounds. By ten months he understands speech and responds to it. True speech develops between 1-2 years.

CHILDHOOD Early - 1-6
 Middle - 6-9/10
 Late - 9/10-13/16

The stage of childhood falls between the years 3 to 12. We shall further classify this stage into Early Childhood (3-6 years) and Middle Childhood (6-12 years).

1. EARLY CHILDHOOD: At this stage of human development the physical, intellectual, emotional and social factors continue to intertwine to make each person unique.

Physical Growth and Change: Physical changes may be less obvious during early childhood than during the first 3 years of life. However, they are nonetheless important, and they make possible dramatic advances in motor skills and intellectual development.

At about age 3, boys and girls begin to lose their chubbiness and begin to take on the slender, athletic appearance of children. As children's abdominal muscles develop, their potbellies slim down. The trunk, arms and legs all grow longer. The head is still relatively large, but other parts of the body continue to catch-up as body proportions steadily become more adult.

Anthropology Paper 01 - Volume 01

Within that overall pattern, children show a wide range of individual and sex-related differences. Boys tend to have more muscles per pound of body weight than girls, while girls have more fatty tissue. Boy's slight edge in height and weight normally continue until puberty.

Structural and Systemic Changes: The changes in children's appearance reflect important internal development. Muscular and skeletal growth progresses, making children stronger, cartilage turns harder, giving the child a firmer shape and protecting the internal organs. These changes, coordinated by the maturing brain and nervous system, allow a proliferation of both large and small muscle motor skills. In addition, the increased capacities of the respiratory and circulatory systems improve stamina and, along with the developing immune system, keep children healthier.

✓ By the age of 3, all the primary teeth are in place and so children can chew anything they want to. The permanent teeth, which will begin to appear before age 6, are developing; therefore, if thumb sucking persists past the age of 5, it can affect how evenly the teeth come in.

Motor Skills: With the child's stronger bones and muscles, greater lung power, and improved coordination between senses, limbs and central nervous system, it can do more and more of the things it wants to do. Between the ages of 3 and 6, children continue to make important advances in motor development.

✓ **Large Muscle Coordination:** At 3, children can walk a straight line and stand on one foot but only for about a second. At 4, they could hop on one foot, and could catch a ball bounced to them, with hardly any misses. At 5, they could jump nearly 3 feet.

Such motor skills - advanced far beyond the reflexes of infancy - are required for sports, dancing and other activities that begin during middle childhood and may last a life time.

Small Muscle and Eye-Hand Coordination: Children at age 3 can draw a nearly straight line and a recognizable circle. At 4, they can cut a line with scissors, draw a person, and make designs and crude letters. With their small muscles under control, children are able to tend to more of their own personal needs and so have a sense of competence and independence. By age 2 or 3 they use one hand more than the other.

✓ **Development of Language:** At the beginning of early childhood, children can give and follow commands that include more than one step. And they can name familiar things like pets, body parts, and people. Their linguistic skills progress rapidly through early childhood. Speech becomes more adult once children pass the age of 3. Children over 3 use plurals and the past tense, and they know the difference between "I", "You" and "We".

Between ages 5 and 6, children use longer and more complex sentences. They can define simple words, and they know some opposites. They use more conjunctions, prepositions, and articles.

Between 6 and 7 years of age, children's speech becomes quite sophisticated. They now speak in grammatically correct compound and complex sentences, and they use all parts of speech.

2. **MIDDLE CHILDHOOD:** Compared with the pace of physical and intellectual development in early childhood, development between the ages of 6 and 12 may seem to be slow. Physical growth slows down considerably except for the growth spurt toward the end of this period and while motor abilities continue to improve, changes are less dramatic than they were earlier. But development at these ages is still highly significant. Intellectual growth is substantial. If the early childhood is made of small children, middle childhood is composed of almost adults.

Physical Development: Both boys and girls gain an average of 7 pounds and 2 to 3 inches a year until the adolescent growth spurt, which begins at about 10 for girls. Then, girls are on average taller and heavier than boys until the boys begin their spurt at about age 12 or 13 and overtake the girls.

Individual children vary widely, however - so widely that if a child who was of exactly average height at his seventh birthday grew not at all for two years; he would still be just within the normal limits of height attained at age nine. Also, growth rates vary with race, national origin and socio-economic level. Given the variance in size during middle childhood, we have to be careful about assessing children's health & identifying possible abnormalities in physical growth.

Motor Development: Middle childhood children are physically active and their motor abilities increase with age. The boys tend to run faster, jump higher and show more strength than girls. After age 13, the gap between sexes widens, boys improve and girls stay the same or decline.

Development of language: Language develops quickly in middle childhood. Children can understand and interpret communications better, and they are better able to make themselves understood. Children develop increasingly complex understanding of syntax by 9 years.

During childhood one can observe the disorganized behavior gradually changing into an organized communication is.

	Girls	Boys
pre pubertal	10-12	13-14
pubescent	12-14	14-16
Post Pubescent	14-18	16-20

A Developmental transition: Adolescence is generally considered as beginning at puberty, the process that leads to sexual maturity, when a person is able to reproduce. Puberty is a part of a long and complex process that begins even before birth. The biological changes that signal the end of childhood produce rapid growth in height and weight, changes in body proportions and form, and attainment of sexual maturity. But adolescence is also a social and emotional process. It has been said that "adolescence begins in biology and ends in culture".

Physical Development: The biological changes that signal the end of childhood include the adolescent growth spurt, the beginning of menstruation for girls, the presence of sperm in the urine of males, the maturation of organs involved in reproduction, and development of secondary sex characteristics.

During puberty, reproductive functions mature, the sex organs enlarge, and secondary sex characters appear. The process takes about 4 years and begins about 2 years earlier for girls than for boys. Girls, on an average, begin to show pubertal change at 9 or 10 years of age, achieving sexual maturation by 13 or 14. Normal girls, however, may show the first signs as early as age 7 or as late as 14. The average age for boys' entry into puberty is 12, with sexual maturity coming at age 14. But normal boys may begin to show changes from ages 9 to 16.

The physical changes of adolescence unfold in a sequence that is much more consistent than their actual timing, though this order varies somewhat from one person to another. Some people move through puberty very quickly, while for others the process takes much longer.

Puberty occurs as response to changes in the body's hormone system, which is triggered by some physiological signal possibly related to a critical weight level. Whatever the signal is, its response in a girl is for her ovaries to sharply step up their production of the female hormone estrogen; and in a boy, for his testes to increase the manufacture of androgens, particularly testosterone. Both boys and girls have both types of hormones, but girls have higher level of estrogen and boys have a higher level of testosterone. As early as age 7, the levels of these sex hormones begin to rise, setting the events of puberty in motion. Estrogen stimulates growth of the female genitals and development of breasts; androgens stimulate the growth of the male genitals and body hair.

Hormones are also closely associated with emotions, specifically with aggression in boys and with both aggression and passion in girls.

The Adolescent growth Spurt: An early sign of maturation is the 'Adolescent Growth Spurt', a dramatic increase in height and weight. It generally begins to appear in girls between ages 9 1/2 and 14 1/2 and in boys between ages 10 1/2 and 16. It typically lasts about 2 years. Soon after the spurt ends, the young

Anthropology Paper 01 - Volume 01

✓ person reaches sexual maturity. Most girls reach their adult height by age 14 or 15, and most boys by age 18.

Before the growth spurt, boys are typically only about 2 percent taller than girls. Since girls growth spurt usually occurs earlier than that of boys, there is a period of several years when girls are taller, heavier, and stronger. After the growth spurt, boys are larger again, now by about 8 percent. The growth spurt in boys is more intense, and its later appearance allows for an extra period of growth, since growth goes on at a faster rate before puberty.

✓ Boys and girls grow differently during adolescence. A boy becomes larger overall, his shoulders are wider, his legs are longer relative to his trunk, and his fore arms are longer relative to both his upper arms and his height. A girl's pelvis widens during adolescence to make child bearing easier, and layers of fat are laid down just under the skin, giving her a more rounded appearance.

In both sexes, the adolescent growth spurt affects practically all skeletal and muscular dimensions. The changes, which are greater in boys than in girls, follow their own time tables, so that parts of body may be out of proportion for a while. The result is the familiar teenage awkwardness that accompanies unbalanced, accelerated growth.

✓ **Primary Sex Characteristics:** The primary sex characteristics are the organs necessary for reproduction. In the female, the sex organs are the ovaries, uterus and vagina; in the male, the testes, prostate gland, penis, and seminal vesicles. The gradual enlargement of these body parts occurs during puberty, leading to sexual maturation.

The principle sign of sexual maturity in girls is menstruation. In boys, the principal sign is the presence of sperm in the urine. Both the onset of menstruation and the first appearance of sperm in the urine are highly variable. Another sign of puberty in a boy is the occurrence of an ejaculation of semen while he is asleep, known as nocturnal ejaculation (wet dream).

✓ **Secondary Sexual Characters:** The secondary sex characteristics are physiological signs of sexual maturation that do not directly involve the sex organs. They include the breasts of females and the broad shoulders of males. Other secondary sex characteristics involve changes in the voice, skin texture, and body hair. The timing of these signs is variable, but the sequence is fairly consistent.

The first sign of puberty for girls is usually the budding of the breasts. The nipples enlarge and protrude; the areolae, the pigmented areas surrounding the nipples enlarge.

Various forms of hair growth, including pubic hair and axillary (arm pit) hair, also signal maturation.

The skin of adolescent boys and girls becomes coarser and oily, and the increased activity of sebaceous glands causes outbreaks of pimples and blackheads. Acne is more common in boys than in girls and seems to be related to increased amounts of the male hormone testosterone. The voices of both boys and girls deepen, partly in response to growth of the pharynx and partly - especially in boys - in response to the production of male hormones.

✓ The most dramatic sign of a girl's sexual maturity is Menarche - the first menstruation, or monthly shedding of tissue from the lining of the womb. Menarche occurs fairly late in the sequence of female development. On an average, a girl first menstruates at the age of 12 1/2, after her growth spurt has slowed down.

MATURITY

Maturity is a long process which includes young adulthood (20 - 40 years) and middle adulthood or middle age (40 - 65 years).

1. **YOUNG ADULTHOOD:** During this stage, people make many of the decisions that will affect the rest of their lives - their health, their happiness, and their success. The interactions among the various aspects of development - physical, intellectual and social - are striking.

Physical Development: A typical young adult is a fine physical specimen. Strength, energy and endurance are now at their peak. From the middle twenties, when most body functions are fully developed, until about age 50, declines in physical capabilities are usually so gradual that they are hardly noticed.

The 20 year old tend to be taller. Between ages 30 and 45, height is stable, and then it begins to decline.

The peak of muscular strength occurs sometime around 25 - 30 years of age; it is followed by 10% loss of strength between ages 30 and 60. Manual dexterity is most efficient in young adults; agility of finger and hand movements begins to lessen after the mid-thirties.

The senses are also sharpest during young adulthood. Visual activity is keenest at about age 20 and does not begin to decline until about age 40. A gradual hearing loss typically begins before age 25; after age 25, the loss becomes more apparent, especially for higher pitched sounds. Taste, smell and sensitivity to pain and temperature generally show no diminution until about age 45 to age 50 or later.

2. **MIDDLE ADULTHOOD:** From young adulthood through the middle years, biological changes generally take place so gradually that they are hardly noticed - until one day a 45 year old man realizes that he cannot read the telephone directory without eye glasses.

Physical functioning and health are usually still good, though not at the peak level of young adulthood. Most people take changes in reproductive and sexual capacities - menopause and the male climacteric - in stride, and some experience a kind of sexual renaissance.

Physical Changes: Although changes in sensory and motor capabilities during mid-life are real and affect people's concept of themselves and their interaction with others, these changes are usually fairly small, and most middle aged people compensate well for them.

Vision, Hearing, Taste and Smell: Throughout life, the lens of the eye becomes progressively less elastic, so that its ability to focus is diminished; this process is usually noticed for the first time in middle age. Many people now need reading glasses for presbyopia, the far sightedness associated with aging. Bifocals - eyeglasses in which lenses for reading are combined with lenses for distant vision - help people make the adjustment between near and far objects. Middle aged people also experience a slight loss in sharpness of vision; and because the pupil of the eye tends to become smaller, they need about 1/3rd more brightness to compensate for the loss of light reaching the retina. Nearsightedness, though, tends to level off in these years.

There is also a gradual hearing loss during middle age, especially with regard to more high-pitched sounds; this condition is known as presbycusis. After about age 55, hearing loss is greater for men than for women. However, most hearing loss during these years is not even noticed, since it is limited to levels of sound that are unimportant to behavior.

Taste sensitivity begins to decline at about age 50, particularly the ability to discriminate "finer nuances of taste". Since the taste buds become less sensitive, foods that may be quite flavorful to a younger person may seem bland to a middle aged person. Sensitivity to smell holds up well; it is one of the last senses to decline.

Strength, Coordination and Reaction Time: Although strength and coordination decline gradually during the middle years, the loss is so small that most people barely notice it. A 10% reduction in

Anthropology Paper 01 - Volume 01

physical strength from its peak during twenties does not mean much to people who rarely if ever exert their full strength in daily life.

People who lead sedentary lives lose muscle tone and energy, and so they become even less inclined to exert themselves physically. A sedentary life style has recently emerged as the major co-relate to deaths from heart attacks. People who become active early in life reap the benefits of more stamina and more resilience after age 60.

Reaction time slows down by about 20% on the average, between ages 20 and 60. Complex motor skills, which increase during the childhood and youth, gradually decline after people have achieved full growth. But the decline does not necessarily result in poorer performance.

Physiological Changes: The most common physiological changes of midlife include a diminished ability to pump blood; reduced kidney functioning; less enzyme secretion in the gastrointestinal tract, leading to indigestion and constipation; weakening of the diaphragm; and in male, enlargement of the prostate gland, which may cause urinary or sexual problems. Some of these changes are a direct result of aging. Still, behavioral factors and lifestyle, dating from youth, often affect their timing and extent. People age at different rates and the decline of the body systems is gradual.

Reproductive and Sexual Capacity: One fundamental change of middle age - the decline of reproductive capacity - affects men and women differently. Women's ability to bear children comes to an end, and although men can continue to father children, they begin to experience lessened fertility and, in some cases, a decrease in potency.

Menopause: The biological event of menopause occurs when a woman stops ovulating and menstruating and can no longer bear children. Menopause is generally considered to have occurred one year after the last menstrual cycle. This typically happens between ages 45 to 55, at an average age of 51.

The Male Climacteric: Although men can continue to father children till late in life, some middle aged men experience a decrease in fertility and frequency and increase in impotence.

The male climacteric is a period of physiological, emotional and psychological change involving a man's reproductive system and other body systems. It generally begins about ten years later than a woman's climacteric.

SENECENCE

The onset of senescence - the period of lifespan marked by decline in body functioning associated with aging - varies greatly. One 80 year old man can hear every word of a whispered conversation, while another has trouble hearing words shouted at him.

Physical Changes: Although sensory and psycho-motor abilities decline with age, there is a great degree of individual variation. Losses of vision or hearing have particularly strong psychological consequences as they deprive people of their activities, social life and independence.

Vision: Older adults report that they have trouble doing a variety of activities dependent on vision. The problems regarding vision stem from deficits in five areas : speed in processing what they see, near vision, light sensitivity, dynamic vision and visual search.

Farsightedness usually stabilizes at about age 60, and with the help of lenses, older people can see well. After 65, however, serious visual problems that affect daily life are all too common. Many older adults have trouble perceiving depth or color. About 16% develop cataract, cloudy areas in lens of eye that prevent light from passing through and thus cause blurred vision.

Glaucoma, another frequent cause of blindness, occurs when fluid pressure builds up, damaging the eye internally.

Hearing: Hearing loss is very common late in life; about 3 out of 10 people between ages 65 and 74 and about half of those between 75 and 79 have it to some degree. Because older people tend to have trouble hearing high-frequency sounds, they often cannot hear what other people are saying, especially when there is a competing noise or buzz.

Taste and Smell: When older people complain that their food does not taste good anymore, it may be because they have fewer taste buds in tongue and also because the olfactory bulb - the organ in brain that is responsible for the sense of smell - has withered.

Sensitivity to Cold and Heat: An older person's body adjusts more slowly to cold and becomes chilled more easily than that of a younger person. Exposure to outdoor cold and to poorly heated interiors may lower body temperature - a serious risk for the aged. Older people cannot cope as well with heat, either, and they often have trouble working in warm temperatures.

Strength, Coordination and Heat: A general slowing down - which affects the quality of responses as well as response time - may result from environmental deprivation and depression, and from neurological changes. Because reflex responses are slowed, loss of bladder and bowel control sometimes occurs.

It takes longer for them to assess the environment, take in all the pertinent information, and make decisions. Slowed information processing shows up everywhere in their lives. The combination of slower information processing, slower reaction time and less efficient sensor motor coordination makes independence more risky.

Other Physical Changes: Many of the changes associated with aging are readily apparent to even the most casual observer - and of course to the elderly themselves. The skin becomes paler, taking on a parchment like texture and losing elasticity. As some subcutaneous fat and muscle disappear, the inelastic skin tends to hang in folds and wrinkles. The hair becomes thinner, what is left turns white, and it sprouts in new places.

People may shrink in size as the disks between their spinal vertebrae atrophy. Osteoporosis, a thinning of the bone that affects some women after menopause, may cause a hump at the back of neck. The chemical composition of bones changes causing a greater chance of fractures.

All the body systems and organs are more susceptible to disease, but the most serious change affects the heart. After age 55, its rhythm becomes slower and more irregular; deposits of fat accumulate around it and interfere with its functioning and blood pressure rises. The digestive system remains relatively efficient : the smooth muscles of the internal organs continue to operate well, and the liver and gall bladder holds up well when obesity is present, it affects the circulatory system, the kidneys, and sugar metabolism; it contributes to degenerative disorders and tends to shorten life.

Reserve Capacity: The human body has the equivalent of money in the bank for a rainy day. Normally, people do not use their organs and body systems to the limit; but extra capacity is available for extraordinary circumstances. This backup capacity, which lets body systems function in times of stress, is called reserve capacity; it allows each organ to put forth 4 - 10 times as much effort as usual. Reserve capacity helps to preserve homeostasis, the maintenance of vital functions within their optimum range.

With age, however, reserve levels drop. Although the decline is not usually noticeable in everyday life, older people cannot respond to the physical demands of stressful situations as quickly or efficiently as they used to. People need reserve capacity just to survive as pedestrians; but because older people cannot call upon fast reflexes, vigorous heart action, and rapidly responding muscles to get out of harm's way, they are more likely to be victims of accidents. In general, then, as reserve capacity diminishes, people may become less able to care for themselves and more dependent on others.

FACTORS AFFECTING GROWTH AND DEVELOPMENT

GENETIC FACTORS

Genetic factors control growth and development right from the formation of an egg or a sperm. These genetic factors control the various stages of growth and development through the life of an individual. The genetic factors and their influence on different stages are discussed.

We have already observed that the human growth and development follows a coordinated sequence. Different characters appear at different stages of growth. These characters in the organism are controlled by genes. Hence, for a coordinated growth, it is essential for the different genes to be activated at specific time periods. This process requires a regulated chain reaction. This regulated chain reaction is called as Induction. The term implies that when one part of the growing embryo is differentiated, it releases substances or "Inducers" for differentiation of another part of the growing embryo. Thus the inducers are responsible for stimulating growth in different parts of the embryo. This leads to a fast organization of the growing embryo.

Inducers are proteins by nature. They act on the cell membranes and thus bring gradual changes in the functional and structural configurations of the cells. These changes are brought about by activating the genes within the cells. The cells of different regions are thus gradually differentiated to form an embryo with different observable regions.

The cell differentiation can only happen when the genes of different cells are activated at specific functional sites. Based on the functions associated with cell differentiation, genes can be classified into two types:

1. **Housekeeping Genes:** These genes synthesize proteins that are required by all types of cells. For example, the proteins required for the formation of cell membrane. These genes, thus, are activated by inducers in all types of cells.
2. **Luxury Genes:** These are related with certain special functions associated with cells differentiations. Hence they are activated in only certain types of cells. For example, the cells which synthesize insulin are activated by inducers responsible for this function.

Cell Division: For any division to occur, the duplication of DNA is essential. Moreover, the synthesis of proteins depends on mRNA. Without such genetic changes, the cells can neither increase in size nor can they be successfully be differentiated. Thus DNA and mRNA control the growth process.

A The duplication of DNA is regulated by DNA-polymerase enzyme and mRNA by RNA-polymerase.

S This transcription of DNA and RNA is actually controlled by proteins called Transcriptional Factors. They help the DNA or RNA to interact with the concerned - polymerase enzyme. Thus genetic factors control growth.

Apart from this, genes also control the metabolism of body which in turn is responsible for normal growth and development. Certain special genes called Homeotic genes control differentiation of the various organs of the body. They are responsible to give identity to the organs and their internal development and functional specialization.

7 **Role of Heredity:** Heredity is a dominant factor controlling growth. It controls growth and development at the following levels:

1. **Phenotype:** The pattern of morphological aspects of children depends on the phenotype of the parents. Thus genes control greatly, though not exclusively, the pattern of growth and development.
2. **Twins:** We have already noted the significance of genetics of twins in the concerned chapter.

3. Sex: The sex of the child is governed exclusively by genetics. Thus even the sex related growth patterns are controlled by genetics.

(4)

(5)

(6)

Apart from this, heredity controls Biorhythms, Dental Eruption and Skeletal maturity.

2 ENVIRONMENTAL FACTORS

- ✓ Human beings though depend on Genetics for basic pattern of growth; environment plays a significant role in controlling growth and development. Its influences are seen in following circumstances.

1. **Migration:** Migration of the human population changes the environment of the group. These changes bring about adaptive modifications in the body and thus influence the growth pattern and direction of development.
2. **Climate:** The climatic factors affect the rate of growth. For example, among the Eskimos, the rate of growth is less compared to their African counterparts. In humid and tropical climate, the rate of growth tends to be faster than in cold environment. However, as Tanner (1992) has noted, there is a considerable individual variation among the human beings with respect to this phenomena.
3. **Emotions:** This aspect of social environment plays a significant role in growth and development. An optimal rate of growth is not seen among children coming from orphanages and broken homes. Anxiety, insecurity and lack of emotional support from the family prejudice the regulation of hormones responsible for growth.

- ✓ Environmental influence is more on people during developmental period during pregnancy and sensitive period after delivery when they are in process of learning. Moreover, environment has more impact on homozygous people than heterozygotes.

3 BIOCHEMICAL FACTORS

- ✓ The entire process of human growth and development is largely a part of interplay between various hormones secreted by the endocrine glands. They are very crucial for normal growth and development. Hormones are active for growth in the stages of prenatal, postnatal and adolescent periods.

HORMONES		
PRE-NATAL GROWTH	POST-NATAL GROWTH	ADOLESCENCE
1. Thyroxin 2. Chorionic Gonadotropin (CG)	1. Thyroxin 2. Growth Hormone (GH)	1. Thyroxin 2. GH 3. Luteinizing Hormone (LH) 4. Follicle Stimulating Hormone (FSH)

Thyroxin: From the above table, it is obvious that thyroxin is active in all stages of growth. From the 12th week of Gestation, the human fetus secretes thyroxin. Thyroxin is responsible for:

1. Increase in permeability of cell membrane for absorption of substances which are responsible for growth.
2. Increasing the number of mitochondria that provide energy for growing cells.
3. Activating DNA and RNA for synthesis of proteins.
4. Increasing responsiveness of tissues to other hormones.

Chorionic Gonadotropin: This hormone is responsible for the stimulation of gonads for secreting other hormones like testosterone. This is responsible for gonadal differentiation and secretion of growth factors responsible for normal growth of fetus.

Anthropology Paper 01 - Volume 01

Growth Hormone: It is secreted by fetal pituitary gland. It is responsible for:

1. Formation of joints of bones.
2. Cell division.
3. Proliferation of cartilaginous tissue.
4. Increase in muscles.
5. Increase in proteins.
6. Fat synthesis.

Reproduction Promoting Hormones: The follicle stimulating hormone and leutinizing hormone are responsible for normal sexual maturity.

FSH: In females it is responsible for development of ovarian follicle, secretion of estrogen and growth of secondary sexual characters, while in males it is responsible for spermatogenesis, growth of testes etc.

LH: In females, LH is responsible for ovulation and in males for secretion of testosterone and secondary sexual characters.

Apart from these, there are also many other biochemical factors controlling growth and development.

NUTRITIONAL FACTORS

Nutrition is considered to be a most important factor affecting growth. Since a proper definition for "optimal growth" is unavailable, the concept of "optimal diet" is less understood. Moreover, the nutritional requirements for individual to individual vary; hence a single dietary regime cannot be prescribed for normal development.

The daily requirement for basal metabolism in the first eighteen months of life averages to about 55 calories / kg. There after, the basal requirement gradually lessens to about 30 calories/kg in an adult. The requirement for activity may vary tremendously per individual at different ages and for the two sexes. In a premature infant the requirement for growth may double as compared to the normal new born.

The distribution of total caloric requirement for boys and girls at different ages is given below: (Watson & Lowrey, 1951).

AGE	TOTAL CALORIC REQUIREMENT PER DAY (CAL/KG)			
	8 WEEKS	10 MONTHS	4 YEARS	ADULT
Basal Metabolism	55	55	30	25
Specific Dynamic Actions	7	7	6	6
Caloric Loss in Excreta	11	10	8	6
Muscular Activity	17	20	25	10
Additional Energy for Growth	20	12	10	0

Malnutrition may cause serious impairment of growth. Malnutrition refers to effects of an inadequate intake of calories. It may also result from diseases which decrease appetite and assimilation.

2012
Oct 23

- The age of diseased organs may be tens of years older than a healthy tissue of a same person.
- Brain cancer tissue in children - had biological age of > 80 yrs.
- Female breast tissue (even healthy one) is older than other tissues.
- Scientists have recently discovered DNA body clock.
- Methylation (a natural process that chemically modifies DNA) varies with age.
- Biological clock is reset to zero when cells plucked from an adult were reprogrammed back to a stem cell like state. Anthropology Paper 01 - Volume 01
- Children suffering from mal-nutrition grow slow. If malnutrition is prolonged for a long time during childhood, the genetic potential for growth is not attained, and the final stature is reduced.

Tempo of growth is the first to be effected by under-nourishment. Adult size is affected even less severe than adult shape. The first five years of a child is a period when he is at a maximum risk from malnutrition.

5 CULTURAL AND SOCIO-ECONOMIC FACTORS

Socio-economic factors play a significant role in controlling development and growth. In 1972, Tanner has observed that there is a height difference among the children of unskilled laborers and managerial class. There is also a difference in time of maturity. Causes of such differences are discussed below:

1. Nutritional Deficiency: Nutritional deficiency among weaker sections may start right from pregnancy. A poor state of economy of the weaker sections deprives a child of a balanced diet. Moreover, illiteracy of the parents may also lead to this problem.
2. Home Environment: The home conditions are a causative factor for growth retardation according to Tanner. They reflect intelligence and personality of the parents that provide emotional needs for normal growth and development of children.
3. Faulty Family Budgeting: A low economic condition of the family is a fountainhead of all deprivations they suffer. Family budgeting never reflects child centeredness.
4. Minor Illnesses: Due to malnutrition, the children are prone to illnesses like cold, measles etc. that have a long-term effect on normal development.
5. Smoking: This habit, both in mothers and fathers, has impact on the fetus. They are born stunted, and this difference prevails throughout the life.

However, due to the developments happening in the fields of society and economy, a secular trend is now obvious in growth patterns. Improved nutrition, improved and clear environment and practices like exogamy have helped develop this new secular trend.

AGEING AND SENESCENCE

Bio Age is the closeness of tissue to death.

The less adaptive the tissue, the older it is.

Diff betw

Ages

(Biological Age - Age at cellular level)
(Chronological Age - Age in yrs.)
Both need not be same

BIOLOGICAL AND CHRONOLOGICAL LONGEVITY

1 The term ageing simply implies growing older, and changes which are related to age, regardless of when in the life span they occur. Senescence however implies changes which occur during the later years of life span when there is a functional decline.

3 Strehler in 1962 has defined senescence as "the changes which occur during the post-reproductive period and it results in decreased survival capacity on the part of the individual organism."

4 Ageing process is an increased liability to die, an increasing loss of vigor, with increasing chronological age, with the passage of time.

5 Senescence and ageing are gradual processes. They are generally initiated at molecular level. The process is advanced much before the external symptoms appear. This process of ageing follows seven steps:

1. From the time of the zygote itself, organisms accumulate a number of substances, which over a period of time cause damage to bio-molecules like DNA within the cell and bio-molecules outside the cell.
2. The damage to bio-molecules impairs intra-cellular and inter-cellular functioning.

Anthropology Paper 01 - Volume 01

3. The efficiency of the cell reduces as a result of this functional impairment.
4. The functional impairment may also lead to cell death.
5. Due to these functional impairments, reduction in the cell efficiency and cell death, the tissues, organs and organ systems lose their functional capacities too.
6. This deterioration of tissues and organs lead to the deterioration of the organism itself.
7. Deterioration of the organism leads to an increased probability of death.

Characteristics: Ageing and senescence have four characteristics. They are:

1. The changes associated with ageing increase the probability of organism's death and hence these changes are deleterious.
2. Ageing decreases the animal's capacity to cope with the environment.
3. The changes associated with ageing are cumulative. This implies that though death is sudden, the processes that lead to death are gradual.
4. The processes associated with ageing and senescence are inescapable. They are the fundamental and intrinsic characteristics of life.

THEORIES AND OBSERVATIONS

Many theories have been put forth to explain the causes of ageing. Some of the important ones are explained here. The theories of ageing can be broadly classified into three groups. The first group of theories attempts to explain the process of ageing as result of intracellular processes and their errors in biochemical processes. The second group of theories concentrate on extra cellular processes that lead to ageing and the last group of theories concentrate on numerous regions of body that go into explaining the process of ageing.

CELLULAR THEORIES

1 Theory of Hayflick Limit

1. In 1965, Leonard Hayflick reported that the human lung fibroblasts divide and their division is limited.
2. The number of cell divisions is roughly related to the age and life span of the species.
3. The longer the life span of a species, the greater is the number of divisions.
4. If cells divide indefinitely, they are abnormal and / or cancerous.
5. Senescence is due to the loss of cell functions that occur before cells reach their maximum division point - the Hayflick Limit.
6. There is a built-in biological clock which decides the cell's capacity to divide the nucleus.
7. Senescence sets in tissues that are more sensitive and then secondarily the other tissues of the body.
8. The potential victim in the case of senescence is the endocrine system.

2 Theory of Free Radical Reaction (Packer & Smith)

1. Free radicals of oxygen are produced in the cells which cause damage and death of a cell.
2. Certain enzymatic reactions are responsible for generating super oxide radical (O_2^-).

3. In the presence of water, this super oxide radical is converted into highly reactive hydroperoxy radical (HO_2).
4. This radical (HO_2) reacts primarily with unsaturated lipids present in the cell to form the pigment lipofuscin - the "Age Pigment".
5. The free radicals are especially harmful when they react in the cell membrane causing the obstruction of the passage through which diffusion of nutrients and excretion of toxins happen.
6. This leads to cell senescence and cell death.
7. This theory was proved by Lester Packer and James R. Smith.

3 Theory of DNA Error

1. Errors in DNA replication process may result from time to time and the errors might also crop up as a result of mutations.
2. If the damage to DNA is undetected by DNA repair system or damages are faster than the action of repair system, these errors accumulate.
3. The accumulated DNA errors impair cell functions and impede the synthesis of essential enzymes.
4. Thus cell senescence sets in and this leads to cell death.
5. This theory is supported by Ronald Hart and Richard Setlow.

4 The Error Catastrophe Theory

1. This concept of "Error Catastrophe" was given by Leslie Orgel and supported by Robin Holliday.
2. Certain types of errors during the process of DNA replication produce a great number of subsequent errors. Thus error in replication would be a "error catastrophe".
3. A mutation in DNA polymerase enzyme gene, which is responsible for DNA replication, would produce a new enzyme which produces further mistakes.
4. Such defective enzymes produced will fill the entire cell with a mosaic of defective proteins.

5 Theory of Missing Factors

1. This theory was propounded by Dr. M. S. Kanungo, a leading gerontologist of India.
2. Ageing is not due to the malfunctioning of a specific gene or genes but due to non-functioning of genes responsible for maintaining adulthood.
3. The malfunctioning may be due to endogenous factors (mutations) and exogenous factors (nutrition, stress).
4. Thus the reproductive phase of individuals depletes certain factors which are responsible for maintaining adulthood.
5. These missing factors accelerate ageing and process of senescence.

EXTRA CELLULAR THEORIES

6 Immunological Theory

1. This theory was supported by Burnet and Walford.
2. The efficiency of the immune system (spleen, lymph nodes, bone marrow and thymus) decrease after attainment of adulthood.

Anthropology Paper 01 - Volume 01

3. The efficiency of thymus gland is especially significant. Its degeneration (after puberty) programs events that lead to ageing of the animal.
4. Immunity can also determine ageing by production of auto-immune responses - the mutations where antibodies are produced against one's own tissues - triggering a fast process of ageing.

7 Collagen Theory:

1. About 40% of the body protein is composed of collagen which is present in extra cellular spaces.
2. Collagen is made of three polypeptide chains which form a super helix.
3. The three chains are supported by non-covalent bonds.
4. As age advances, the three chains are further stabilized by covalent bonds.
5. Because of this change in the property of collagen, a healthy intracellular environment is not kept and the movement of products is thus obstructed.
6. This leads to accumulation of toxins and under nourishment of cell and thus to cell senescence.

MODERN THEORIES

8 Programmed Ageing Theory

10. Telomeric Theory -

1. Bodies age according to a normal development pattern built into every organism.
2. This program is only subject to minor modifications.
3. This pattern of ageing is predetermined and inborn.
4. This inborn mechanism of programmed ageing is supposed to be confined to Chromosome-1 or Chromosome-21.

9 Wear and Tear Theory

1. Body ages because of continuous use - ageing is the result of accumulated "insults" to the body.
2. As time passes, when cells grow older, they are less able to repair or replace damaged components.
3. Internal and external stressors aggravate the wearing down process.

HUMAN PHYSIQUE AND SOMATOTYPES

Human somatotyping studies refer to the study of the personality of an individual based on the physical constitution.

HUMAN PHYSIQUE

An analysis of human populations reveals that the human beings are characterized by different constitutions. Human constitution or physique is consistent. It is consistent in the sense that the various aspects of its structure, function or behavior are almost permanent and do not show any change in the individual as time lapses.

The human physiques can be identified and classified into different somatotypes based on morphological, physiological and behavioral characteristics. This aspect of human physique and its classification into different somatotypes is reserved for the later part of discussion.

The human physique is influenced by numerous factors like environment and genetics. However, it is clear today, after the recent developments in the science of human genetics, that the human physique is largely determined by the genetic constitution of the individual. This is the reason why we have stated earlier that it cannot be subjected to change easily during the life span of the individual.

- ① Human somatotypic studies refers to the study of personality of an individual based on physical constitution.
- ② The physique can be identified & classified into diff somatotypes based on morphological, physiological & behavioural characteristics.
- ③ HP is largely determined by genetic constitution & less by environment.

SOMATOTYPES

Though we have noted that physiological and behavioral aspects also govern the human physique, morphology has been the most popular level through which human beings are somatotyped. Broadly, four systems of classification are employed for human somatotyping.

✓ Sheldon and others in 1940 devised a method to analyze and quantify human body form and called it as somatotyping. According to them, "Somatotypes are morpho-phenotypic ranges along constantly recognizable characteristics and are the functional end products of the whole genetic and developmental complex".

✓ The Somatype is aimed at providing a sort of identification tag to an individual and may be regarded as an attempt towards general human taxonomy or classification.

1. **Viola System:** This system is developed by an Italian physician Viola. This system recognizes four somatotypes, based on the measurements and relative indexing of individuals. These somatotypes are :

- Longotype:** Have relatively long limbs compared to the trunk, massive thorax compared to the abdomen, and greater transverse diameters compared to antero-posterior ones.
- Brachitype (Broad type):** Have characters opposite to longotype.
- Normative:** This type constitutes those individuals who fall in between longotype and brachitype categories.
- Mixed Type:** This category includes those individuals, who exhibit characters of different types in different parts of the body, i.e., they may be brachitype in one part, longotype in another and normotype in yet another part of the body.

The Viola system of somatotyping has however fallen into disuse.

2. **Kretschmer's System:** This system is developed by Kretschmer, a German psychiatrist. This system is based on anthroposcopic inspection. There are three somatotypes according to this system.

- Pyknic Somatype:** Broad, round and fat, sturdy and stocky.
- Leptosome Somatype:** Long, thin and linear.
- Athlete Somatype:** Heavily muscled, large thorax and shoulders and narrow hips.

The Kretschmer's system is today outmoded. This is because this system classified human beings into fixed, discrete classes though intermediary between these are easily recognized. Moreover, this system lacked any detail compared to Viola's system.

3. **Sheldon's System:** This system recognized three basic components of physique, viz., endomorphy, mesomorphy and ectomorphy. Each individual has varying degrees of development of these three components. The somatype is always written in three numerals; the first indicating the development of endomorphy, the second the mesomorphy and the third representing ectomorphy. The numerals fall between 1 and 7, the scale chosen by Sheldon to indicate the level of development.

Sheldon's observations were based on 4000 undergraduate male students in the age range of 16 - 20 years by taking photographs. For the purpose of morphological observations, Sheldon divided the body components into five areas:

1. Head, face and neck.
2. Thorasic trunk

3. Arms, shoulders and hands
4. Abdominal trunk, and
5. Legs and feet.

Each component was scored from 1 to 7 as the somatotype of the subject. Each somatotype was thus represented by a three digit combination, i.e., 7-1-1 as extreme endomorph, 1-7-1 as extreme mesomorph and 1-1-7 as extreme ectomorph.

Brief description of each component follows as under:

1. **Endomorphy:** Reflects general softness and roundness of the body and its various forms. Proximal parts are relatively massive than distal ones, tapering of extremities, abdomen predominating over thorax, soft body contours, relatively small hands and feet.
2. **Mesomorphy:** Reflects general massiveness and sturdiness of the musculo-skeletal system of the body, highly developed limb muscles with distal segments of the extremities relatively more prominent. Strong and highly muscular thorax which predominates over abdomen with small antero-posterior diameter of trunk than the transverse one.
3. **Ectomorphy:** Reflects thin and lean body with weak muscles and thin skeletal diameters, pointed and sharp body projections, long and slender extremities with little muscles over them.

Critical evaluation:

1. This method is subjective.
 2. This method is developed on white males of limited age range, ignoring all the other ages, races and females.
 3. Ignores role of environment on human physique and considers the latter to be static from birth to death.
 4. Overall body size and shape of the subject is ignored.
4. **Heath - Carter Method of Somatotyping:** Heath, in 1963, critically examined the short comings of Sheldon's method and came out with certain modifications and later in collaboration with Carter, gave her own method of somatotyping in 1967. This method differs from Sheldon's method in the sense that it evaluates the physique at a given time compared to the unchanging somatotype of Sheldon. The ratings of three primary components of physique are assigned as the basis of following anthropometric measurements. - a) Height, b) Body weight, c) Supra-spinal skin fold, d) Calf skin fold, e) Humerus diameter, f) Femur diameter etc.
1. **First component (Endomorphy):** Refers to relative flatness in individual physiques, as well as to relative leanness.
 2. **Second component (Mesomorphy):** Refers to relative muscular skeletal development per unit height.
 3. **Third component (Ectomorphy):** Refers to relative linearity of individual physiques. Evaluates the form and degree of longitudinal distribution of first and second components.

Evaluation:

1. Is it highly objective.
2. An excellent tool to explore spatial-temporal variations in human body form.

- 3. An easy, accurate and efficient method.
- 4. Method workable in field as well as laboratory.

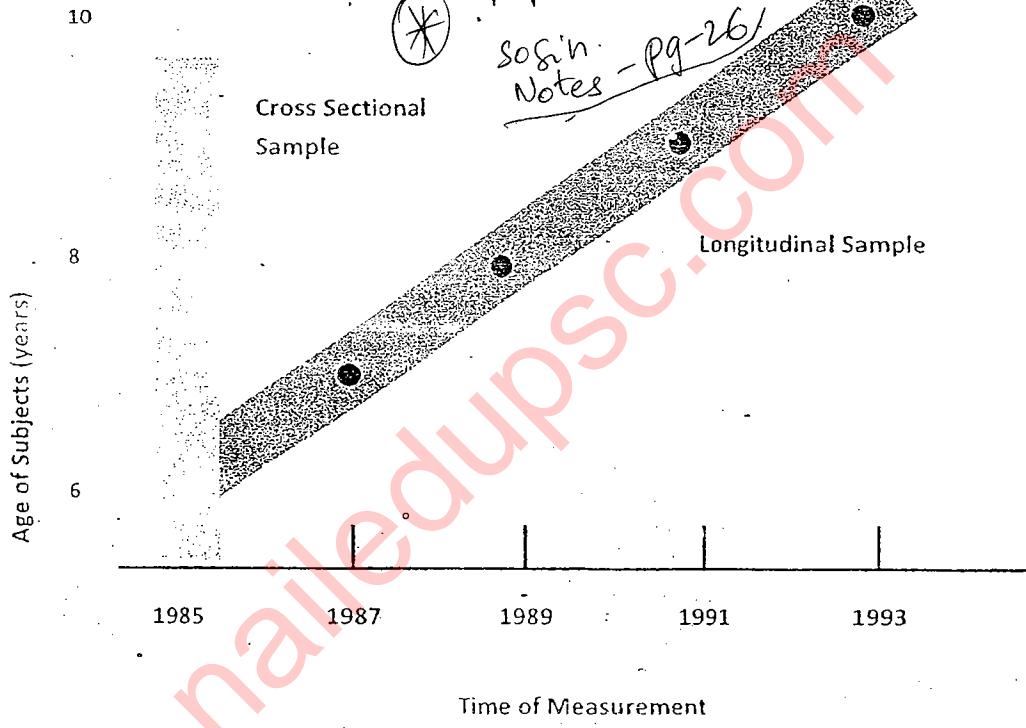
Applications

Human somatotyping has not only a theoretical importance but also an enormous applied value. The somatotype technique is today increasingly used in the field of kinanthropometry, anthropology of sports. By comparing somatotypes of different regions, the role of environment can also be easily deduced.

(1) studying relation b/w diseases & body physique
 (2) racial classification

METHODOLOGIES FOR GROWTH STUDIES

Information about growth and development is most commonly gathered by cross sectional or longitudinal studies. In some cases, sequential designs are used.



In a Cross Sectional Study, people of different ages are assessed on one occasion. This kind of study provides information about differences in development among different age groups, rather than changes with age in the same person (which longitudinal studies show).

In a Longitudinal Study, researchers measure the same people more than once to see changes in development over time. The researchers may measure one characteristic, such as vocabulary, size, IQ, height or aggressiveness. Or they may look at several aspects of development, to find interrelationships among factors. Since the same people are measured more than once, this design gives a picture of the process of development.

Cross-sectional studies, then, look at differences among groups of people; longitudinal studies assess changes undergone by one or more persons. Each design has strengths and weaknesses.

The advantages of cross-sectional method include speed and economy; it is faster and cheaper than the longitudinal method. In addition, it does not lose subjects who drop out. Among its drawbacks is its masking of differences among individuals, since it looks at group averages. Its major disadvantage is that

Anthropology Paper 01 - Volume 01

- ✓ it cannot eliminate cohort, or generational, influences on subjects born at different times. Cross-sectional studies are sometimes misinterpreted as yielding information about developmental changes in groups of individuals; but such information is often misleading and may contradict longitudinal research. For example, it would be incorrect to conclude from the cross-sectional study that intellectual functioning declines in later years. This may be so, but longitudinal data would be needed to determine whether there were actual age changes. All that the cross-sectional method can show is that there were age differences in performance.
- ✓ The great strength of longitudinal studies is their sensitivity to individual patterns of change, since data about individual patterns of change can be tracked. Also, they avoid cohort effects within a study – although longitudinal studies done on one particular cohort may not apply to a different cohort. Longitudinal studies, however, are time consuming and expensive. Another shortcoming is probable bias in the sample; people who volunteer tend to be of higher than average socioeconomic status and intelligence, and those who stay with the project over time tend to be more competent than those who drop out. Also, the results can be affected by repeated testing; people tend to do better in later tests because of a "practice effect".

Sequential Studies

- ✓ The cross-sequential study is one of several strategies designed to overcome the drawbacks of longitudinal and cross-sectional studies. This method combines the other two: people in a cross-sectional sample are tested more than once, and the results are analyzed to determine the differences that show up over time for the different groups of subjects.
- ✓ Some important research on intellectual functioning in adulthood employs sequential techniques. These techniques seem to provide a more realistic assessment than either the cross-sectional method (which tends to overestimate the drop in intellectual functioning in later years) or the longitudinal method (which tends to underestimate it).

11 Social Demography

11.1 Relevance of Menarche, Menopause and other Bioevents to Fertility

Fecundity and Fertility: Fecundity refers to the "capacity of a man, a woman, or a couple to participate in reproduction - i.e., the capacity to produce a live child. Fertility, on the other hand, refers to "the actual reproductive performance - whether applied to an individual or a group". While there is no direct measurement of fecundity, fertility can be studied from the statistics of births. The fertility of an individual is limited by his/her own fecundity—the physiological capacity to reproduce. The fecundity of an individual may be quite normal, yet the fertility performance may be low, for the term fecundity is biological, whereas fertility indicates the actual level of reproductive performance determined by social, cultural, psychological and even economic factors. Fecundity also refers to maximum fertility level that can be attained.

Sterility: While a man or a woman or a couple who has given birth to at least one live child, is considered fertile, one who has not had a single child is sterile. The term sterility may be used in connection with individuals or groups, consisting of either men or women or both. Sterility can be natural/involuntary or artificial/voluntary.

Reproductive Span: The biological limits imposed on child bearing by such factors as age and sex can be easily recognized. Only women can conceive and give birth to children and that too within certain age limits. A woman becomes biologically fecund with the onset of menstruation. The onset of menstruation is called Menarche. Her capacity to bear children comes to an end with the onset of Menopause, when menstruation ceases. On the basis of research evidence, women can bear children from age of 15 to 44 years. The reproductive span of men is not well defined, nor is it easily identifiable, though it is generally found to be considerably longer than that of women.

Theoretical Maximum Fertility: Theoretically, during the physiologically limited child bearing period, a woman would get 37 children, if she gave birth to one child every ten months over a period of 31 years. Such a phenomenon is however very rare. There is a gap between fecundity and actual fertility. This gap is because of the operation of many physiological or biological factors along with social as well as cultural factors.

Adolescent Sterility: The fecundity of females is not uniform throughout the reproductive span of 30 to 35 years. Then woman's age is an important factor when her reproductive capacity is considered. Female fecundity is at a low level during the early stages of puberty. A certain degree of adolescent sterility (sterility among the adolescent age group) or sub-fertility is observed for girls between the ages of 13 and 18 years. Adolescent sterility or sub-fertility occurs because regular ovulatory cycles are not generally firmly established for the first two or three years after the onset of menstruation. The interval between menarche and the attainment of full biological maturity to bear children is therefore called the period of adolescent sterility. A woman's capacity to bear children reaches the highest level at 20 to 25 years, after which it starts declining first slowly and then after the age of 38 quite rapidly and reaches zero level at about 50 years.

Post-Partum Sterility: During the reproductive span of women, there are certain periods of temporary sterility. After the birth of a child, the woman is generally sterile for some period, as the menstrual cycle is not resumed, or if it is reestablished, the earlier cycles are un-ovulatory. This post-partum period in which menstruation is not resumed is known as the post partum amenorrhea period. During this period, the possibility of conception is very rare and hence this period of temporary sterility is known as the post partum sterility. It has been reported in many Indian studies that as a result of breast-feeding the post partum amenorrhea period is longer.

Reproductive Wastage: Reproductive wastage in terms of abortions and stillbirths also act as physiological factors affecting fertility.

- (1) Isip events to fertility
- (2) Oogenesis - ovulation
- (3) Transport of spermatozoa in female reproductive tract
- (4) Capacitatum - process of removal of inhibitory proteins produced by MRT (or) spermatozoa & be able to fertilise the ovum.

- (5) Acrosome reaction
- (6) Zona reaction & Vitelline
- (7) Syngamy
- (8) Fertilisation
- (9) Zygote - mitosis
- (10) Pre-natal growth

FERTILITY PATTERNS AND DIFFERENTIALS

It has been observed that the levels and patterns of fertility vary considerably in various sub-groups of the same population. These subgroups may be based on residence, whether urban or rural, social and economic status in terms of educational attainment, occupations, income, size of land holding, religion, caste, race, etc. A study of differential fertility is useful in identifying the factors which determine fertility levels among various sub-groups. The information so provided gives us some idea of the future proportion of each group in the total population and also helps us to project more accurately the future population size of the entire country. A study of differential fertility is also important from the point of view of the implementation of family planning programs because it helps us to identify high fertility groups on which the program's efforts can be concentrated. In this connection, it is interesting to note that in the 1930s, when birth rates were at the lowest levels, research was concentrated on those groups which had the lowest fertility with a view to uncovering clues for the formation of policies for the encouragement of high fertility among these very groups.

Differential fertility can be understood as a result of following factors.

(*) Cessent fertility Rate in India, World? (2.7)

ECOLOGICAL FACTORS

- Regional Differences in Fertility:** The fertility rates of various regions or States or provinces within one country may differ widely. In India, for instance, there is a great deal of variation in the fertility levels of various States and Union Territories.
- Rural-Urban Residence and Fertility:** Numerous studies have been conducted on fertility differentials according to rural-urban residence. Towards the end of the last century, in the low fertility areas of the world, it was found that the fertility of those residing in cities was lower than that of rural residents and these differentials were more or less stable. However, when during 2 wars national birth rates declined these fertility differentials widened in a more pronounced manner among urban upper classes than among others. Rural-urban differences narrowed down again when birth rates rose after the Second World War.

SOCIO-ECONOMIC FACTORS

- Educational Attainment and Fertility:** The educational attainment of couples has a very strong bearing on the number of children born. Educational attainment, especially of women, is one of the indicators of modernization and the status of women in society. In low fertility countries, historically the relationship between fertility and the educational attainment of the wife has been a negative one, in the sense that the higher the educational level, the lower was the family size.
- Economic Status and Fertility:** General studies in the past have highlighted the inverse relationship between the economic status of the family and fertility. This traditional relationship is now undergoing substantial changes as far as the developed countries are concerned.
- Occupation of Husband and Fertility:** In developed countries occupation, especially that of the husband is used as an indicator of social economic status, and differential fertility is studied according to the occupation of the husband. Studies conducted in Europe around 1970 indicated that the wives of farmers and farm workers recorded a higher fertility than the wives of men engaged in non agricultural occupations. Even amongst those engaged in agriculture, the fertility of the group of farm workers was higher than that of the group of farmers. These differences were more pronounced in France and the United States than in the other countries. Manual workers were also found to have, on an average, more children than non manual workers. In India, some studies have tried to investigate the relationship between the occupation of the husband and fertility. It was generally observed that the wives of those engaged in professional jobs had the lowest fertility.
- Employment of Wife and Fertility:** It has been found in several studies that the gainfully employed women have a smaller number of children than those who are not employed. Though this
- b. Age at marriage of couple esp wife

relationship has been quite distinct in many industrialized countries, the exact nature of this relationship is not yet known. Is it that women who have smaller number of children tend to take paid jobs outside their homes, or is it that those who have already paid jobs restrict their family size to the very minimum so they can work? It is difficult to say anything very firmly.

e. Religion, Caste, Race and Fertility: Religion is considered to be an important factor affecting fertility. The study of differential fertility of various religions as well as ethnic groups has important social and political implications. In a democratic society where each person has the right to vote, the size of a particular religious, caste or ethnic group may be an important factor in determining the political power-structure. Several studies have been conducted in developed as well as developing countries to investigate the influence of affiliation to a particular religion on the fertility behavior of the people. At one time, all the religions of the world, except Buddhism, were pro-natalist or "populationist". The injunctions laid down in various religions indicate the importance of high fertility. Some illustrations are: "Be fruitful, multiply and replenish the earth" (Judaism and Christianity); "Marry a woman who holds her husband extremely dear and who is richly fruitful" (Islam); "Make the bride the mother of good and fortunate children, bless her to get ten children and make the husband the eleventh one" (Hinduism). It may however be pointed out that all these religions have their roots in the distant past, which was a period of high mortality. As such, the emphasis on prolific fertility was a functional adjustment to high mortality in order to ensure the continuation of the group. Resistance to human interference with fertility is common to all religions. As pointed out by Lorimer and Osborn this resistance has been less persistent in those religious groups where there was an absence of a central authority as in the case of Judaism and the Protestant sect of the Christian religion. This same reason, namely the absence of a central authority, may be attributed to the absence of opposition to birth control among the Hindus.

a(i) Various studies in the West, which is essentially dominated by the Christian-Hebraic tradition, show that the fertility of Catholics has exceeded that of non-Catholics in almost every country and socioeconomic group. The studies conducted in the United States and Canada have clearly pointed out that the fertility of Roman Catholics has been higher than that of either Protestants or Jews. Recent findings indicate that in most of the European countries as well as in Canada, differentials in fertility by religious affiliation are narrowing. The reason for this narrowing of differences may be due to modifications in the religious sanctions relating to the ideology and practice of birth control and the weakening of the influence of religious doctrines and traditions. It may also be that the influence of other socioeconomic factors such as urban residence, educational attainment etc. on fertility is on the wane with the result that fertility differentials are narrowing.

a(ii) India may be taken as an illustration from the developing countries. In most of the studies conducted in India to study the fertility behavior of various religious groups it was observed that the Muslims had a higher fertility rate than the Hindus or the Christians.

a(iii) Some sociologists are of the opinion that minority religious groups may tend to have higher fertility rates to gain more political power. This however does not hold true in all cases. Two minority communities, that is, the Zoroastrian community in India and the Jewish community in the United States, have always shown lower fertility rates than the majority group. Other socio-economic factors such as the educational attainment of the wives, the status of women, the degree of modernization of the community, etc., are found to affect the fertility of the subgroups in a particular society.

From this discussion it is obvious that it is difficult to determine the exact role of religion in influencing fertility and that the role of religion in causing fertility differentials though not negligible is quite limited.

b ✓ As caste is an important indicator of social status in India, attempts have been made in several studies to observe fertility differentials by caste. In a study conducted in Lucknow City, it was observed that

✓ upper caste Hindus had, on an average 3.8 live births while the lower caste Hindus had on an average 4.1 births.

✓ In multi-racial societies differences in fertility have been found among various racial groups. In the United States, for example, the Negroes show a higher fertility than the white community. These differences, however have been explained away by socio-economic factors.

6. Inter-relationships between Socio-Economic Variables Affecting Fertility: In the discussion on differential fertility only one variable at a time has been taken into consideration with a view to explaining the differences in fertility among various sub-groups in any population. It must however be recognized that all these variables are closely interrelated. For example, when the husbands are highly educated, they tend to have educated wives. Higher educational levels are related to higher incomes and more gainful occupations leading to higher standards of life. In a community in which women are educated, the influence of religious dogma is likely to be less rigid, while if the community has a high proportion of illiterate women, religious influences tend to be strong and affect fertility. Age at marriage is also closely associated with the educational attainment of wives.

1,2,3 on pg 248)

✓ When fertility differentials are studied in relation to various ecological, socioeconomic and cultural factors, it is found that, in many developed countries, they are narrowing, and the latest trend is towards uniformity. On the other hand, in a developing country like India, fertility differentials have in recent times become increasingly pronounced. Amos Hawley has identified three phases in the trends in fertility differentials. In the first phase, various socio-economic classes either had identical fertility rates or the relationship between socioeconomic status and fertility was positive. In the next phase, which began with industrialization and the resulting socioeconomic development, it was the highly educated urban elite group which first began to show declines in fertility thus showing a wave of fertility differentials. In the final phase, which is in existence now in many Western countries, there appears to be a positive association between socio-economic status and fertility. India is at present in the transitional stage of declining fertility and therefore differentials among various socio-economic classes are becoming increasingly more pronounced.

11.2 Demographic Theories – Biological, Social and Cultural

WHAT IS DEMOGRAPHY?

✓ Demography is the study of human populations, their growth and decline due to changing patterns of migration, fertility and mortality and characteristics such as the Sex-ratio, dependency ratio, and age-structure. The subject is sometimes divided for further elucidation into 'formal demography', meaning the formal statistical analysis of population parameters and dynamics, and 'population studies', the wider investigation of the causes and consequences of population structures and change. It is in the latter area that many demographers have interests which overlap with those of sociologists and anthropologists and in their investigation demographic analysis forms an important component in the description and understanding of human societies.

✓ The methodology of demography consists of analysis of databases of official statistics from births, deaths, and marriage registration, and from population censuses. Demographers seek ultimately to produce population projections that forecasts not only of the size of the population over coming decades, but also its changing age-structure, which can be important for social policy and labor-market policy. For example, if the dependent population (children under school-leaving age and people over retirement age) is growing relative to the population of working age which has to support it financially, there may be major implications for taxation, social insurance, and fiscal policy. If the population of working age is declining in absolute numbers, there may be a case for government policy to encourage a larger percentage (of women especially) to enter employment. Thus demographic statistics and analyses provide the essential underpinning for many other types of study. For this reason population censuses were the very first type of systematic social enquiry to be developed.

Limitations of statistics

Analyses of vital statistics (statistics of births, deaths, marriages etc., of a country) do however have their limitations. In particular, they cannot supply information on the motivations, value-systems, or aims and preferences underlying changes in the birth-rate, which is a key factor in population growth. In recent years, there have been concerted efforts to develop and carry out interview surveys on fertility orientations and behavior. These cover issues such as the preferred number of children in a family, the effects of household income and women's employment on their fertility, attitudes to contraception and its use-all factors affecting the timing and spacing of births.

ANTHROPOLOGY AND DEMOGRAPHY

Demographic behavior is a part of individual's whole socio-psychological behavior, which has a decisive effect on the possibility of some demographic event. The socio-economic system of the society guides demographic behavior and by employing concepts of demography, socio-economic conditions can be clearly understood.

The foregoing discussion reflects the relation between anthropology and demography. Moreover, the relation between these two sciences becomes even clearer when one realizes that a majority of problems connected with population are classified as social problems. Values are fundamental to any society and functioning of any culture. Hence, demography cannot afford to ignore the study of social values which provide the context in which every human population grows and thrives to survive. This demands a holistic approach, especially drawing from the principles, concepts and methodology of anthropology. Even the success and failure of family planning programs are determined by socio-cultural consciousness of people. Brown and Selznick have noted that the areas of concern of both sociology and demography are common - social organization, collective behavior, urbanization, primary groups etc. This reveals the inseparable relationship between anthropology and demography and prevents any underestimation of their functional interdependence.

SOCIAL DEMOGRAPHY

✓ Social demography is a field of study concerned with the analysis of how social and cultural factors are related to population characteristics. Its major focus is the impact of social and cultural factors on demographic features of society such as patterns of marriage and child bearing, the age-structure of the population, life-expectancy, and so forth. In addition however, social demography also encompasses ✓ examination of the social consequences of demographic change. Since the demographic characteristics of a society or social group are themselves social phenomena, and the immediate product of the social (but also biological!) events of birth and death, in one sense the demographic study of any human population is a form of social demography. However, whereas demography itself is primarily concerned with determining and measuring population characteristics and the interrelationship between demographic variables, social demographers seek to understand and explain these demographic patterns. In so doing they draw on the expertise of anthropology, sociology as well as of demography.

✓ The three main variables underlying population change are fertility, mortality, and migration, variables themselves associated with factors such as age at marriage, the proportions marrying, contraceptive use, levels and types of morbidity, rural-urban migration, and so forth. All receive attention from social demographers, who seek to understand these processes in terms of a range of standard social factors such as the levels and distribution of income, levels of education, the position of women, religion, and economic development.

THEORIES OF DEMOGRAPHY



MALTHUSIAN THEORY OF POPULATION

Thomas Robert Malthus attempted a population-resource relation in his Malthusian Principle of Population. The Malthusian theory of population is an economic approach to demography and is an empirical statement (since it is based on the population experience of West European Countries). The

2 Assumption

1

Theory is based on two assumptions. The first assumption is that food is always necessary for mankind.

- 1) The implications of this assumption are 1) Population growth is limited by the means of subsistence 2) Population growth increases in a proportion to the increasing means of subsistence (i.e. food) and 3) Population growth increases with increasing means of subsistence unless moderated by certain "Checks".

The second assumption of the Malthusian theory is that the passion between both the sexes will remain at the same levels of intensity throughout human history. The implications of this assumption are 1) birth rates will remain at relatively high levels (due to undiminished passion between sexes) and 2) population growth will proceed in a geometric ratio. According to Malthus, these two assumptions are immutable (unchangeable) principles and are also opposed to each other. The relation between these two principles will be such that while food production grows in an arithmetic ratio (1, 2, 3, 4), the population will grow in a geometric ratio (1, 2, 4, 8). As a result of this kind of relationship, the gap between population and food availability will continuously widen. This widening gap will have two consequences. The first consequence is the increasing stress of rising population on the natural resources which provide sustenance. This will lead to breakdown of the natural ecosystems triggering natural catastrophes.

The second consequence of the widening gap between food availability and rising population is the widening gap between the rich and the poor. The rich will try to control more resources but at the same time they do not produce many offspring fearing decline of their standard of living.

2 Checks

The Malthusian catastrophe (natural catastrophes in the form of famines and floods) will be inevitable unless some checks come into operation. The checks can be preventive and positive. The positive checks are largely outside the control of man and include war, disease, poverty etc. The preventive checks are within the control of Man and include factors such as moral restraint, birth control measures including abortion and vice such as adultery, and pre-marital sex. According to Malthus, man should take active steps by resorting to preventive checks to prevent the Malthusian catastrophe (breakdown of resource systems) from occurring. Though Malthus talked about birth control as one of the preventive steps, he was not convinced about contraception. According to him, contraception would not lead to delaying of marriage and hence would increase birth rates in the long run (on the assumption that lack of sex would drive people to work hard for preparing the ground for marriage, but with contraception people can indulge in sex early and also marry early).

Criticisms

Though the population theory of Malthus initiated theory building in population-resource relationships and also brought into sharp focus the importance of stable land-man ratios, a series of criticisms have been leveled against it. For e.g., it has been pointed out that Malthus could not envisage how technological revolutions would lead to greater provision of sustenance, thereby freeing Man from the threat of Malthusian catastrophes. It is also argued that Malthus mixed up a purely biological instinct (the desire to have sex) with a purely social instinct (the desire for children) by invoking the principle of undiminished passion between sexes. In addition, the arithmetic vs. geometric ratios for food growth and population growth has failed empirical validity in different regions of the world. The theory is also criticized on two other counts - its greater emphasis on positive checks and the unethical nature of preventive checks.

2 THEORY OF OPTIMUM POPULATION

The advocates of Optimum Population Theory, especially Edwin Cannan, hold the view that population should grow to a desired / optimum level. Any increase in the population beyond this level is harmful to the society. The stage of optimum population would reach when the society is able to run its minimum and essential services. The situation can be optimum or satisfactory when the death rates equal birth rates.

This theory is based on the assumption that there is a close relation between population size and economic development. Economic development presupposes optimum utilization of all the resources and population constitutes the human resources which are employed to exploit both natural resources as well as capital. In countries where there is less population, in terms of labor, population growth is necessary

to ensure use of all the available resources. This situation where the available resources are fully utilized is "Optimum Population". In the event of continued population growth beyond the stage of optimum population, then it would result in disturbance of balance of resources for production and economic development. This is because such growth would ensure a situation where more labor is available than what is "ideally" needed.

The theory of optimum population is based on the following two principles:

1. The rates between total population and working population remained constant even though there is an increase in the population.
2. The availability of natural resources and capital do not change proportionate to change in population. This results in operation of Law of Diminishing Returns.

CLASSICAL THEORY OF DAVID RICARDO

Ricardo adopted classical economic model to population growth. According to him, in early stages, the growing demand for labor pushes up the population growth rate. As the labor supply increases, the wages begin to decline. Ultimately, equilibrium is established between the demand and supply of labor. Once this equilibrium is established, capital accumulation in the economic system stops which leads to everyone receiving the same wage. This acts as a deterrent to further population growth because, beyond this level, population growth would lead to universal poverty.

THEORY OF HERBERT SPENCER

The British philosopher, Spencer, proposed a natural law of population growth based on the relationship between individuation and genesis. According to this theory, Man's interest in reproduction decreases with increasing socio-cultural development because of the antagonism between individuation and genesis. Hence as the society evolves, its fecundity will also decrease. This is a natural law which therefore absolves Man from any responsibility for controlling his numbers, as Nature achieves this by reducing Man's reproductive interests with increasing cultural development.

THEORY OF KARL MARX

Marx approaches the problem of population growth dialectically and his theory of population is a critique of capitalism. The two classes which make up a capitalist society respond differently to population growth according to Marx. The rich own the means of production and do not increase their numbers rapidly because labor is not an asset to their class. The poor, on the other hand, do not own any other means of production except labor, the only asset the class possesses. As a result, the poor tend to accumulate labor through rapid population growth. Eventually, the poor uproot the capitalist order by a revolution and assets are equally owned by all. Population growth is therefore slowed down. But, population growth can be slowed down by adopting the Communist system instead of letting a class revolution uprooting the capitalist system. The communist method of production would therefore solve the problem of rapid population growth.

CYCLICAL THEORY OF CORRADO GINI

According to Corrado Gini, the growth of human population follows the cycle of growth of the individual. Hence, it follows that the first stage of rapid growth would eventually be replaced by a second stage of slow growth.

Stage 1: This is the stage of rapid population growth. Gini maintains "every nation in its youth is simple and undifferentiated in its structure and has a high rate of fertility, because each generation springs from the people who are hereditarily most prolific i.e. highly fecund". Organizations become more and more complex as the numbers increase. The structure of the society becomes more and more complicated as

Anthropology Paper 01 - Volume 01

industrial and commercial activities grow. At this stage, attempts are made to check population either through colonialism or war.

Stage 2: In this stage the population decreases. Gini gives two reasons for this trend.

- 1) Colonization or war resulting in loss of young and energetic people
- 2) Increase in the number of upper-class population which is less prolific than the lower class population.

The reason for this decline is biological and hence the decline in fertility is due to a decline in fecundity. As the lower class people move up the ladder to become members of upper class, even they reflect the lowered fertility rate. Gini notes "Even the sterility of these climbers is not a consequence of social conditions surrounding their climbing; it is rather a result of weakening of the reproductive instinct and is an inevitable phase of cycle of population growth". He continues his argument while saying that there would be a decline in quality of individuals due to decline in population and this is the result of change in the hereditary quality of individuals. The rise and fall of population is determined by an inevitable natural growth and he thus invoked some sort of "mystical" biological changes which determined both the qualitative and quantitative changes in human populations. Moreover, these biological changes were beyond the control of human beings. Thus, his theory analogizes population growth to human cycle of birth, growth and death.. Corrado Gini's theory is supported by Bertrand Reed's conception of population growth which he represented graphically by letter 'S'. According to this school of mathematical theorists on demography, the growth of population is slow initially, gradually increases later and steadily till it reaches a mid-point."

THOMAS SADLER'S DESTINY AND FECUNDITY PRINCIPLE

Michel Thomas Sadler's theory was actually put forth as a critique of Malthusian theory on population. He opined that nature's laws about population were just the opposite of those which were enunciated by Malthus. He put forth his principle in his book "The law of population" as "the fecundity of human beings is in inverse ratio of the conversion of their numbers".

Labor and Privacy, according to Sadler are two important pre-requisites for maintaining population growth. The desire to put in labor and hard working attitudes are decreasing according to him with growth and advancement of civilization. This is mainly because machines started replacing the humans. Lack of privacy emerges as a consequence of shortage in accommodation. Because of reduction in labor and lack of privacy, there will be a reduction in population fertility rate. He thus concludes that nature, contrary to Malthusian conception, is helping mankind rather than having a negative approach towards population. Though this theory has been criticized on a number of grounds, especially on the ground that Sadler was confused with the distinction between fertility and fecundity, it remains significant because it was successful in removing pessimism which was created by Malthusian theory.

DIET THEORY OF THOMAS DOUBLEDAY

Thomas Doubleday drew a correlation between the diet of the people and population growth. He believed that man's increase in numbers was inversely proportional to his food supply. That is, the better the food supply, the slower the increase in numbers. In all those societies where food supply is in shortage, fertility rates are usually higher, contrary being the case in societies where there is good food supply. Population, Doubleday maintains, rapidly increases where people get very little food. He says "There is in all societies a constant increase going on amongst that portion of it which is worst supplied with food, instead among the poorest. He further extended his theory to dietary habits. He says that the non-vegetarians have less capacity to reproduce. He gives this as a reason for low density of population among pastoralist societies. Similarly, fertility is bound to be highest where population is purely vegetarian while it is moderately high among people who are both vegetarian and non-vegetarian.

José de Castro's Theory of Protein Consumption which he elucidated in his book "Geography and Hunger" also points to similar conclusions as Doubleday's. Castro too has come out with a negative correlation between protein intake and birth rates of various countries. He concludes that poor countries are highly populated because they have undernourished population which is more fertile.

③ THEORY OF DEMOGRAPHIC TRANSITION (Notestein)

Relatively, the Theory of Demographic Transition is a recent one. This theory is more rational as it is based on the demographic experience of many nations, especially those of the west. A majority of sociologists and an equal number of economists as well as demographers believe that the population dynamics in any country pass through a series of stages, each stage having its peculiarity. Though scholars are divided about the classification and grouping of these stages, the Theory of Demographic Transition is widely accepted as a framework through which the processes of population can be well understood.

Though there are many contributors to and proponents of this theory, it was however Notestein in the year 1945, who gave it a natural form. The theory postulates a three stage sequence of birth and death rate as typically associated with economic development.

First Stage of Demographic Transition:

According to this theory, death rates are high in the first stage of an agrarian economy on account of poor diets, primitive sanitation and absence of effective medical aid. Birth rates are also high in this stage as a consequence of widespread prevalence of illiteracy, absence of knowledge about family planning techniques, early age of marriage and as a consequence of deep-rooted social beliefs and customs about the size of the family, attitude towards children, etc. Moreover, in a primitive society there are economic advantages of a large family size. "Children contribute at an early age ... and are the traditional source of security in the old age of parents. The prevalent high death rates, especially in infancy, imply that such security can be attained only when many children are born." In such a society the actual rate of growth of population is not high since high birth rate is balanced by high death rate. It is a stage of high growth potential but of low actual growth.

Second Stage of Demographic Transition: (Stage of population explosion)

Rise in income levels enables the people to improve their diet. Economic development also brings about all-round improvement including the improvement in transport which makes the supply of food regular. All these factors tend to reduce death rate. Thus in the second stage, birth rate remains high but death rate begins to decline rapidly. This accelerates the growth of population. High growth potential of the first stage is realized in the high actual growth in the second stage as a consequence of decline in death rate. High birth rate and falling death rate contribute to the growth of the average size of the family in the second stage.

The Third Stage of Demographic Transition: (Stage of incipient decline of population)

Economic development further changes the character of the economy from an agrarian to a partially industrialized one. With the growth of industrialization population tends to shift away from rural areas towards industrial and commercial centers. Growth of urban population "with the development of economic roles for women outside the home, tends to increase the possibility of economic ability that can better be achieved with small families, and tends to decrease the economic advantage of a large family. One of the features of economic development is typically increasing urbanization, and children are usually more of a burden and less of an asset in an urban setting than in a rural." The consciousness to maintain reasonable standard of living tends to reduce the size of family in an industrialized economy; since the death rate is already low, this is possible only if birth rate falls. Thus, the characteristics of the third stage are low birth rate, low death rate, small family size and low growth rate of population. This is the stage of incipient decline of population.

These three stages reveal the transformation of a primitive high birth and high death rate economy into a low birth and low death rate economy. When an economy shifts from the first stage to the second stage of demographic transition, an imbalance is created in the economy as a result of falling death rate but relatively stable birth rate. Historically it has been observed that death rate can be controlled more easily because the measures to reduce death rate are exogenous in nature and hence readily acceptable to the people. But the reduction of birth rate can be brought about by operating on endogenous factors, like changing social attitudes and customs, beliefs and dogmas about the size of the family, about marriage, etc. This requires a much longer time than the fall of death rate. Consequently, birth rates tend to fall after a time lag. The second stage of demographic evolution has, therefore, been termed as the stage of population explosion. This stage is the most hazardous period for a developing economy. The decline in death rate in the second stage, therefore, creates an imbalance which requires a period of transition for adjustment. Thus, the theory is termed as the theory of demographic transition. During the period of transition the demographic factors get out of harmony. A new constellation of demographic forces is brought about which changes the character of society, birth and death rates become balanced at a lower level as a result of which growth rate of population also declines.

11.3 Biological and Socio-ecological Factors Influencing Fecundity, Fertility, Natality and Mortality

FERTILITY

Births or fertility occupies a central place in the study of population because of the following reasons:

1. Fertility is responsible for biological replacement of life and maintenance of human society.
2. The growth of population depends to a very large extent on fertility.
3. The society replenishes itself through fertility.
4. Fertility is a positive force counteracting the negative force of mortality or deaths.

MEANING OF FERTILITY

- 1) Lewis and Thompson: - "Fertility is generally used to indicate the actual reproductive performance of a woman or groups of women".
- 2) Bernard Benjamin: - "Fertility measures the rate at which a population adds to itself by births and is normally assessed by relating the number of births to the size of some section of population ... as an appropriate yardstick of potential fertility".
- 3) Barclay: - "The fundamental notion of fertility is an actual level of performance in a population, based on the number of live births that occur".

FECUNDITY, FERTILITY AND NATALITY

Fecundity is the capacity to conceive or bear children. It is defined as a "biological potential or the physiological capacity to participate in reproduction." The absence of fecundity is called sterility or infecundity. It is the potential level of performance (or the physical capacity for bearing children) of the population. Fertility on the other hand refers to the actual reproductive performance of individual or group. It follows that fertility of an individual will be limited by the physiological capacity to reproduce i.e., fecundity.

- ✓ Natality is the birthrate, which is the ratio of total live births to total population in a particular area over a specified period of time; expressed as childbirths per 1000 people (or population) per year.

- (1) Polygamy
- (2) Widowhood
- (3) Family system - Nuclear, Joint
- (4) Social customs, superstitions

- (1) Govt employee incentives
- (2) Benefit programs

Anthropology Paper 01 - Volume 01

(See next page for chart)

FACTORS DETERMINING FERTILITY

Biological
Socio-cultural
Political

A causal analysis of fertility may involve a great number of factors and complicated chain reactions. It is therefore appropriate to make a systematic classification of the mechanisms which directly affect fertility through which all other factors must operate. An excellent categorization of these mechanisms has been devised by Kingsley Davis and Judith Blake. Their most basic concept is that the birth of a child is not possible unless...

- 1) Sexual intercourse has occurred
- 2) Intercourse has resulted in pregnancy
- 3) Pregnancy has been brought to successful term.

Building on this concept, they have devised as list of eleven variables which directly affect fertility. They term these "intermediate variables" since any other variables which may affect fertility must ultimately act through one of these.

I. Factors Affecting Exposure to Intercourse:-

A. Those governing the formation and dissolution of unions in the reproductive period.

1. Age of entry into sexual unions
2. Permanent celibacy; proportion of women never entering into sexual unions
3. Amount of reproductive period spent after or between unions
 - i. when unions are broken by divorce, separation or desertion
 - ii. when unions are broken by death of husband

B. Those governing the exposure to intercourse within unions

- 4 a. Voluntary abstinence
- 5 b. Involuntary abstinence (from impotence, illness, and unavoidable but temporary separations)
- 6 c. Coital frequency (excluding periods of abstinence) (freq. of intercourse)

II. Factors Affecting Exposure to Conception:-

- 7 d. Fecundity or infecundity, as affected by involuntary causes

- 8 e. Use or non-use of contraception

- a. by mechanical or chemical means
- b. by other means

- 9 f. Fecundity or infecundity, as affected by voluntary causes (sterilization etc).

III. Factors Affecting Gestation and Successful Parturition:-

- 10 g. Fetal mortality from involuntary causes

- 11 h. Fetal mortality from voluntary causes.

Now we shall look into these variables in some detail.

1. **Age of Entry into Sexual Unions:** In the European nations' culture a couple is not supposed to marry until the husband is able to support a wife and family. In pre-industrial Europe the age of marriage was relatively low but began to rise gradually. Ohlin has suggested that the rise in the age at marriage could plausibly be explained by the decline in mortality, since the average man now had to wait longer before inheriting land or advancing from his apprenticeship. In many Asian nations, on the other hand, the age at first marriage has always been very early, since marriages are arranged and the husband is not expected to support his family entirely by his own efforts.
2. **Permanent Celibacy:** A rather high proportion of permanent celibates are frequent in the nations which have a late average age at marriage.
3. **Amount of Reproductive Period Spent after or between Unions:** To some extent in all societies actual fertility is reduced below the biologically maximum level because part of the reproductive period is spent after or between sexual unions. Where monogamy is institutionalized it is almost inevitable that a certain proportion of widows never remarry, since there are almost always considerably more widows than widowers, and many widowers prefer to marry never-married

Physiological factors

- ① Adolescent fertility
- ② Post - partum sterility
- ③ Primary sterility
- ④ Reproductive wastage

Intercourse variables

- ① Age of entry into sexual union
- ② Permanent celibacy
- ③ Union see back(2)(i)
- ④ 3 (ii)
- ⑤ B(a) -
- ⑥ B(c)

Conception variables

- ① II(e)
- ② ~~III(f)~~ involuntary causes
- ③ II(f)

Gestation variables

- ① III(g)
- ② III(h)

Anthropology Paper 01 - Volume 01

women. Periods of separation between marital unions are also important in some societies in reducing fertility. Many legal marriages and consensual unions breakup and the breakup may be caused by marital incompatibility, or in many cases may occur simply because the woman does not want to incur the choice of an additional pregnancy.

4. **Voluntary Abstinence:** Certain primitive societies enjoy periods of voluntary abstinence on special ceremonial occasions. Almost all societies enjoy a period of abstinence during late pregnancy and also during the early postpartum period. The former has no detrimental effect on fertility and the latter has little since almost all women have very low biological fecundity during this time. Of the various forms of voluntary abstinence, the "rhythm period" probably has the greatest effect on fertility. This method of birth control demands abstinence in the days before and around the time of ovulation, which generally occurs around the mid-point of the menstrual cycle. When properly practiced, it will reduce the conception rates rather drastically.
5. **Involuntary Abstinence:** In a few societies a large proportion of men must absent themselves from their wives periodically to obtain gainful labor.
6. **Frequency of Intercourse:** Much theoretical evidence suggests that this variable may be rather important in determining differences in fertility between individuals, whether or not it affects the fertility of different populations is another question. It is possible, however, that factors such as diet, temperature, humidity and the prevalence of certain enervating diseases may have effects on the average frequency of sexual intercourse in different populations. This is clearly a field where we need much more information than we now have.
7. **Fecundity or Infecundity as Affected by Involuntary Causes:** Several factors may affect the probability of conception given the fact that intercourse occurs at a specified frequency. On a worldwide basis perhaps the chief of these is the incidence of venereal disease. Venereal disease affects the fecundity of both men and women. Extreme hunger has also been found to cause amenorrhea (and hence temporary sterility) in women and a reduced sperm count in men. Modern medical science has made considerable progress in reducing the proportion of persons who are involuntarily childless. The use of antibiotics in case of venereal diseases has been very important in this respect. Another advance has been the use of artificial inseminations to impregnate women whose husbands are sterile. New drugs have recently been developed which stimulate ovulation and allow certain women to conceive who otherwise would probably never be able to do so.
8. **Use or Non-use of Contraception:** According to popular belief, contraception is the most important of all the intermediate variables affecting fertility. Actually, although there is no doubt that contraception is very influential in reducing levels of fertility, it is definitely not so overwhelming a contribution that the other variables can be ignored.
9. **Fecundity or Infecundity as Affected by Voluntary Causes:** The surgical operations of tubectomy in females and vasectomy in the males provide an individual permanent freedom from further parenthood. On a worldwide basis, prolonged breast feeding is one of the most important means by which a woman may temporarily reduce her fecundity. Women are sterile during their period of postpartum amenorrhea and a short period of an ovulatory cycle following the resumption of their menses. Prolonged lactation has a pronounced effect on the length of the period of post partum sterility. According to Robert Potter, the period of post partum sterility averages 13 months in a population which engages in prolonged lactation, and only four months in a population with no lactation.
10. **Fetal Mortality from Involuntary Causes:** On average, about 20% of all known pregnancies are spontaneously aborted. There is much individual variation in the proportion of pregnancies which miscarry, but little is known how populations may vary in this respect.

II. Fetal Mortality from Voluntary Causes: Induced abortion is one of the most important means of birth control. Primitive methods of abortions have been practiced through out human history.

FACTORS ASSOCIATED WITH LONG-TERM DECLINE IN FERTILITY IN DEVELOPED COUNTRIES

In this section the factors which have brought about a change from high fertility to low fertility in developed countries will be discussed in detail.

see
new
page

Motivational Factors: Motivational factors have played an important role in bringing about a change from high fertility to low fertility. Demographers are of the opinion that over the years tremendous changes have occurred in the attitudes of couples towards reproduction. It appears that they have moved away from a strong positive desire to have several children to a strong motivation for a limited family. It is difficult to provide research evidence in support of this shift in the attitudinal and motivational forces which came in the wake of the social and economic conditions arising out of the Industrial Revolution. It is however quite evident that these forces operated at the level of individual couples, who translated into action the desire for a small family, for the social atmosphere was not favorable to birth control, nor were there any effective means of contraception. The State in most and the Church in all the cases did not approve of birth control. In fact, as Gunnar Myrdal put it, "All the forces of organized society-the law, officialdom, the clergy, educators, the press, the medical profession-were mobilized to prevent birth control from spreading". Yet the strong motivation of individual couples drove them to the achievement of their desired goal of having small families.

Economic and Social Factors: The phenomenon of fertility decline in the now developed countries is very complex. Several interacting and overlapping economic and social factors were responsible for the transition from high to low fertility. It follows therefore that no single factor can be held responsible for this fertility decline. In what follows, some economic and social factors are reviewed in the context of fertility declines. These are: (i) industrialization; (ii) urbanization; (iii) rising levels of living and increased costs of bringing up children; (iv) family functions and structure; (v) relationship between mortality and fertility; and (vi) social mobility. The process of industrialization began towards the middle of the eighteenth century, first in England and later throughout Europe and North America. It brought in its wake several far-reaching economic and social changes, which in turn brought about fertility declines. Most important, the process of industrialization initiated the process of modern economic growth; the per capita productivity increased and real income rose. Advancements in science and technology further improved the productivity of labor, for they created conditions in which workers received better education and training, worked shorter hours as a result of social reforms, and had better nutrition because of increased availability of food supplies. Several structural changes also took place about the same time. The share of agriculture to total product and that in the labor force decreased; there was a corresponding rise in the share of industry and other non-agricultural sectors. Industrialization was accompanied by urbanization. Declines in mortality were registered because of agricultural, economic and social development that came in the wake of industrialization.

Several changes accompanied growing industrialization and urbanization, which had implications for fertility decline. Of particular interest are the changes which took place in the structure and functions of the family - the basic unit of society. The family lost its function as an economic unit, in the sense that it ceased to be a producing unit and became only a consumer unit. With the introduction of laws which prohibited child labor and made education compulsory, the economic usefulness of children to their parents was drastically reduced. In fact, they became a liability because of the increasing costs and lengthening duration of education. At the same time, there were declines in mortality, especially infant and child mortality; more children survived and the burden of bringing them up fell entirely on the nuclear family. Parents soon realized that, because of declining mortality, there was no need to have a large number of children in the hope that a few at least would survive. They therefore had fewer children. The advantages of rising real incomes flowing from industrialization were in danger of being nullified by large families, especially because of the rising costs of bringing up children. A large family was therefore seen as a threat to maintenance of a certain standard of life, and couples responded to this

threat by having a smaller number of children. Rising costs of child rearing was thus an important factor in fertility declines in developed countries. Certain measures initiated by the Governments of various countries also contributed to changes in the attitudes of parents towards their children. Financial responsibility for medicines and medical treatment, provision of old age security, etc., which were originally shouldered by the family, were taken over by the State in many countries. Children therefore were no longer the only source of old age security. With the spread of education among women, social attitudes to women, as well as the attitudes of women to themselves, underwent profound changes. It was realized that a woman need not be restricted to her age-old role of homemaker and bearer of children. Women began to participate in gainful employment which provided an alternative to childbearing and child-rearing. Education was also responsible for bringing about a rational outlook, free from religious dogma; and this rational outlook facilitated the acceptance of the idea of fertility control. Moreover, flowing from educational opportunities and rising prosperity was the aspiration on the part of the individual to rise in the social scale. Too many children were perceived to be an obstacle in the attainment of this objective to climb the social ladder; and the natural result was the limiting of the size of the family.

According to Frank W. Notestein, the noted demographer, the growth of a huge and mobile city population largely changed the corporate family way of traditional society; instead came individualism, which was characterized by increasing personal aspirations to move upward. Large families became "progressively a difficult undertaking; expensive and difficult for a population ever increasingly freed from old taboos and increasingly willing to solve its problems rather than accept them." Notestein pointed out in 1953 that the decline in fertility in the West occurred as a result of the growth of an urban industrial society. He concluded that the development of technology was the underlying factor for fertility transition. He also pointed out that "industrialization and urbanization resulted in little development of a rational and secular point of view; the growing awareness of the world and modern techniques through popular education, improved health, and the appearance of alternatives to early marriage and child-bearing as a means of livelihood and prestige of women".

The reasons for the recent declines and low current levels of fertility in most of the developed countries may be summarized as follows: (1) Development of improved methods of fertility control and increasing use of the most effective methods; (2) Liberalized abortion laws and extensive grounds and facilities for abortion; (3) Decreasing desire for large families; (4) Rising costs of rearing child; (5) The increasing trend of women's employment in paid jobs outside the home; (6) Instability and changes in the values attached to the rewards and penalties of parenthood in the context of other needs and aspirations.

FACTORS RELATED TO HIGH FERTILITY IN DEVELOPING COUNTRIES

In order to understand the factors which are responsible for high fertility, it is necessary to study the social, cultural and economic conditions prevalent in the countries with high fertility, which may then be compared with the conditions in the countries where fertility has declined. The following section considers the same factors that were identified earlier for fertility declines in low fertility countries, but in a different context.

Motivational Factors and Factors Relating to Family Structure and Functions: Two general explanations are put forward for the high fertility in some countries. The first explanation is that high fertility is a fundamental adjustment to high mortality and that high fertility is necessary for group survival when mortality is high. When infant and child mortality rates are high, this consideration becomes even more important, because to have a large number of children in those circumstances becomes necessary in view of the fact that the chances of survival of children to adulthood are slender. Even when infant and child mortality rates begin to decline following improved health services, this fact does not become immediately evident to the people.

The other explanation is that high fertility is also an adjustment "to the central importance in community life of familial and kinship ties. In preindustrial societies, all activities are centered on kinsmen and

Anthropology Paper 01 - Volume 01

children and a great deal of occupational co-operation is required from them to the large tasks that are to be carried out. In fact, in such societies, economic and social relationships overlap.

The production and consumption of goods and services, leisure-time activities, assistance in illness and old age and several other activities, which are normally entrusted to various non-familial institutions in complex societies, fall in the domain of the family and kinship groups in pre-industrial societies.

- ✓ In such a social structure children have a great economic, social, cultural as well as religious value. They become economically useful by the age of six or seven, and therefore are not an economic liability for their parents, but are, in fact, economic assets. In most pre-industrial societies, great importance is attached to the procreation of male children, for sons extend the family line. Amongst the Hindus, a son is essential, for only he can ceremoniously kindle the funeral pyre and thus affect the salvation of his father's soul. He is also responsible for performing religious services for his ancestors. Children are generally considered to add to the wealth and prestige of the family for with the increase in the number of children and consequent increase in relatives and grandchildren come more political power and additional economic resources for the family.

Even when children migrate to urban areas, they continue to add to the family income because of strong family ties and their sense of duty towards parents which is ingrained in traditional societies. In such societies, biological parents may not be called upon to provide for the basic needs of their children, for the family is jointly responsible for all the children born into it. There is, therefore, no economic motivation for restricting the number of children.

- ✓ In most traditional societies, a fatalistic attitude to life is ingrained and fostered from childhood. Such an attitude acts as a strong influence against any action that calls for the exercise of the right of the self determination with reference to reproduction. It is for this reason that, when people are asked how many children they would like to have, they are sometimes known to reply: "It is not for us to decide," "Children are the gifts of God," etc. Religious institutions also generally promote high fertility rates which are definitely incorporated in the tenets of Hinduism, Judaism, Islam and Christianity, especially among the Roman Catholics.

Economic, Social and Other Factors: The motivational factors mentioned above are supported by the low level of economic and social development which exists in most developing countries today in spite of the fact that the process of industrialization has already commenced in these countries. In most developing countries, there is still widespread poverty, and the literacy rates are low. The status of women is also quite low, leading to their unquestioning acceptance of excessive child-bearing without any alternative avenues for self-expression. The general low level of living leads to an apathetic state of mind, and there is hardly any desire to improve the standard of life. Lack of education acts as a constraint on rational and secular living, and the influence of religious dogmas persist. The result of all these factors is that the size of the family grows without any inhibiting influences.

Taking all these factors into account, the governments of most developing countries have launched official family planning programs to educate their people to accept, in keeping with the changing times, the small family norm. Though these family planning programs cannot be a substitute for economic and social development, and are definitely not meant to be so, they can be quite effective in augmenting the control of fertility.

DIFFERENTIAL FERTILITY

It has been observed that the levels and patterns of fertility vary considerably in various sub-groups of the same population. These subgroups may be based on residence, whether urban or rural, social and economic status in terms of educational attainment, occupations, income, size of land holding, religion caste, race, etc. A study of differential fertility is useful in identifying the factors which determine fertility levels among various sub-groups. The information so provided gives us some idea of the future proportion of each group in the total population and also helps us to project more accurately the future

population size of the entire country. A study of differential fertility is also important from the point of view of the implementation of family planning programs because it helps us to identify high fertility groups on which the program's efforts can be concentrated. In this connection, it is interesting to note that in the 1930s, when birth rates were at the lowest levels, research was concentrated on those groups which had the lowest fertility with a view to uncovering clues for the formation of policies for the encouragement of high fertility among these very groups.

Differential fertility can be understood as a result of following factors.

ECOLOGICAL FACTORS:

- (c) **Regional Differences in Fertility:** The fertility rates of various regions or States or provinces within one country may differ widely. In India, for instance, there is a great deal of variation in the fertility levels of various States and Union Territories.
- (d) **Rural-Urban Residence and Fertility:** Numerous studies have been conducted on fertility differentials according to rural-urban residence. Towards the end of the last century, in the low fertility areas of the world, it was found that the fertility of those residing in cities was lower than that of rural residents and these differentials were more or less stable. However, when national birth rates declined these fertility differentials widened in a more pronounced manner among urban upper classes than among others. Rural-urban differences narrowed down again when birth rates rose after the Second World War.

SOCIO-ECONOMIC FACTORS:

- f. **Educational Attainment and Fertility:** The educational attainment of couples has a very strong bearing on the number of children born. Educational attainment, especially of women, is one of the indicators of modernization and the status of women in society. In low fertility countries, historically the relationship between fertility and the educational attainment of the wife has been a negative one, in the sense that the higher the educational level, the lower was the family size.
- g. **Economic Status and Fertility:** General studies in the past have highlighted the inverse relationship between the economic status of the family and fertility. This traditional relationship is now undergoing substantial changes as far as the developed countries are concerned.
- h. **Occupation of Husband and Fertility:** In developed countries occupation, especially that of the husband is used as an indicator of social economic status, and differential fertility is studied according to the occupation of the husband. Studies conducted in Europe around 1970 indicated that the wives of farmers and farm workers recorded a higher fertility than the wives of men engaged in non agricultural occupations. Even amongst those engaged in agriculture, the fertility of the group of farm workers was higher than that of the group of farmers. These differences were more pronounced in France and the United States than in the other countries. Manual workers were also found to have, on an average, more children than non manual workers. In India, some studies have tried to investigate the relationship between the occupation of the husband and fertility. It was generally observed that the wives of those engaged in professional jobs had the lowest fertility.
- i. **Employment of Wife and Fertility:** It has been found in several studies that the gainfully employed women have a smaller number of children than those who are not employed. Though this relationship has been quite distinct in many industrialized countries, the exact nature of this relationship is not yet known. Is it that women who have smaller number of children tend to take paid jobs outside their homes, or is it that those who have already paid jobs restrict their family size to the very minimum so they can work? It is difficult to say anything very firmly.
- j. **Religion, Caste, Race and Fertility:** Religion is considered to be an important factor affecting fertility. The study of differential fertility of various religions as well as ethnic groups has important social and political implications. In a democratic society where each person has the right to vote, the

size of a particular religious, caste or ethnic group may be an important factor in determining the political power-structure. Several studies have been conducted in developed as well as developing countries to investigate the influence of affiliation to a particular religion on the fertility behavior of the people. At one time, all the religions of the world, except Buddhism, were pro-natalist or "populationist". The injunctions laid down in various religions indicate the importance of high fertility. Some illustrations are: "Be fruitful, multiply and replenish the earth" (Judaism and Christianity); "Marry a woman who holds her husband extremely dear and who is richly fruitful" (Islam); "Make the bride the mother of good and fortunate children, bless her to get ten children and make the husband the eleventh one" (Hinduism). It may however be pointed out that all these religions have their roots in the distant past, which was a period of high mortality. As such, the emphasis on prolific fertility was a functional adjustment to high mortality in order to ensure the continuation of the group. Resistance to human interference with fertility is common to all religions. As pointed out by Lorimer and Osborn this resistance has been less persistent in those religious groups where there was an absence of a central authority as in the case of Judaism and the Protestant sect of the Christian religion. This same reason, namely the absence of a central authority, may be attributed to the absence of opposition to birth control among the Hindus.

Various studies in the West, which is essentially dominated by the Christian-Hebraic tradition, show that the fertility of Catholics has exceeded that of non-Catholics in almost every country and socioeconomic group. The studies conducted in the United States and Canada have clearly pointed out that the fertility of Roman Catholics has been higher than that of either Protestants or Jews. Recent findings indicate that in most of the European countries as well as in Canada, differentials in fertility by religious affiliation are narrowing. The reason for this narrowing of differences may be due to modifications in the religious sanctions relating to the ideology and practice of birth control and the weakening of the influence of religious doctrines and traditions. It may also be that the influence of other socioeconomic factors such as urban residence, educational attainment etc. on fertility is on the wane with the result that fertility differentials are narrowing.

India may be taken as an illustration from the developing countries. In most of the studies conducted in India to study the fertility behavior of various religious groups it was observed that the Muslims had a higher fertility rate than the Hindus or the Christians.

Some sociologists are of the opinion that minority religious groups may tend to have higher fertility rates to gain more political power. This however does not hold true in all cases. Two minority communities, that is, the Zoroastrian community in India and the Jewish community in the United States, have always shown lower fertility rates than the majority group. Other socio-economic factors such as the educational attainment of the wives, the status of women, the degree of modernization of the community, etc., are found to affect the fertility of the subgroups in a particular society.

From this discussion it is obvious that it is difficult to determine the exact role of religion in influencing fertility and that the role of religion in causing fertility differentials though not negligible is quite limited.

As caste is an important indicator of social status in India, attempts have been made in several studies to observe fertility differentials by caste. In a study conducted in Lucknow City, it was observed that upper caste Hindus had, on an average 3.8 live births while the lower caste Hindus had on an average 4.1 births.

In multi-racial societies differences in fertility have been found among various racial groups. In the United States, for example, the Negroes show a higher fertility than the white community. These differences, however have been explained away by socio-economic factors.

Inter-relationships between Socio-Economic Variables Affecting Fertility: In the discussion on differential fertility only one variable at a time has been taken into consideration with a view to explaining the differences in fertility among various sub-groups in any population. It must however be

Anthropology Paper 01 - Volume 01

recognized that all these variables are closely interrelated. For example, when the husbands are highly educated, they tend to have educated wives. Higher educational levels are related to higher incomes and more gainful occupations leading to higher standards of life. In a community in which women are educated, the influence of religious dogma is likely to be less rigid, while if the community has a high proportion of illiterate women, religious influences tend to be strong and affect fertility. Age at marriage is also closely associated with the educational attainment of wives.

When fertility differentials are studied in relation to various ecological, socioeconomic and cultural factors, it is found that, in many developed countries, they are narrowing, and the latest trend is towards uniformity. On the other hand, in a developing country like India, fertility differentials have in recent times become increasingly pronounced. Amos Hawley has identified three phases in the trends in fertility differentials. In the first phase, various socio-economic classes either had identical fertility rates or the relationship between socioeconomic status and fertility was positive. In the next phase, which began with industrialization and the resulting socioeconomic development, it was the highly educated urban elite group which first began to show declines in fertility thus showing a wave of fertility differentials. In the final phase, which is in existence now in many Western countries, there appears to be a positive association between socio-economic status and fertility. India is at present in the transitional stage of declining fertility and therefore differentials among various socio-economic classes are becoming increasingly more pronounced.

MORTALITY

- ✓ Historically, the factor of mortality has played a dominant role in determining the growth of population, the size of which fluctuated in the past mainly in response to variations in mortality. The increase in the population of European countries following the Industrial Revolution in the seventeenth century was mainly due to a decline in the death rates. The developing countries which are undergoing a typical demographic transition have also been affected initially by the fall in the death rates. In fact, the single most important contribution of demography has been the revelation of the fact that sharp declines in mortality rates, rather than any rise in the fertility rates, have been responsible for bringing about a rapid growth of population.
- ✓ The study of mortality is useful for analyzing current demographic conditions as well as for determining the prospects of potential changes in mortality conditions of the future. The public health administration depends heavily on the study of mortality, for statistics on death in the population cross-classified by age, sex and the cause of death are of great value for the formulation, implementation and evaluation of public health programs. Statistics on deaths also form the basis of the policies of insurance companies.

It is of course possible to study mortality from several angles, for various biological, social, economic and cultural factors affect the health of an individual and consequently the mortality rate in society. These factors affecting mortality can be classified under heredity, constitution and environment. When mortality is viewed from the demographic point of view, it is studied to determine changes in the population size and structure, rather than from the medical angle. The demographic study of mortality therefore does not usually take into consideration the genetic factor. The remaining two factors, namely, the constitutional and the environmental factors provide the basis of a demographic analysis of mortality. Of the various constitutional factors - including the physical, physiological, anatomical and psychological characteristics of man - the most important for the demographic study of mortality are age and sex. The environmental factors affecting mortality include the natural physical surroundings of the individual as well as his/her social and economic environments and personal habits.

CONCEPT OF MORTALITY

The study of mortality deals with the effects of death on population. Though the meanings of terms "life" and "death" are obvious, a scientific study of demographic processes calls for formal definitions.

The United Nations and the World Health Organization have defined death as follows: "Death is the permanent disappearance of all evidence of life at any time after birth has taken place (post natal cessation of vital functions without capacity of resuscitation).". A death can thus occur only after a live birth, and the span between birth and death is life.

The above definition of death does not include any death prior to a live birth, which has been defined by the United Nations as follows: "Live birth is the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered live-born." It is, therefore, evident that any death prior to a live birth is not considered as a death. Thus, abortions and still births are referred to, not as deaths, but as fetal deaths. Any expulsion of the fetus, either spontaneous or induced, which occurs before the fetus becomes viable, that is, capable of independent existence outside its mother, is known as an abortion. When a birth does not have any of the characteristics included in either of these two definitions of live birth or abortion, it is known as a still birth.

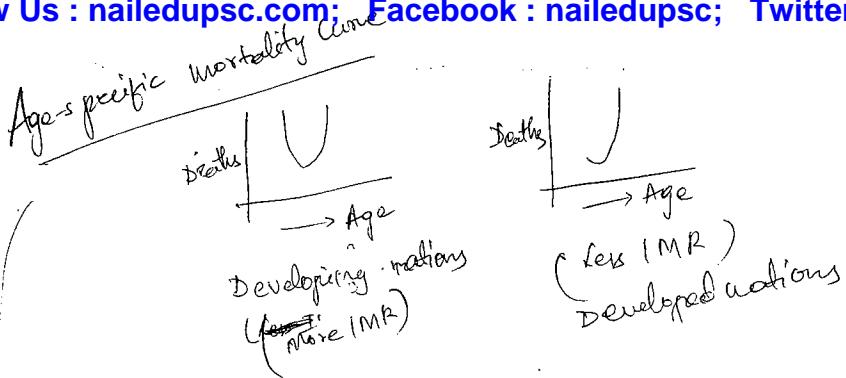
SEX AND AGE PATTERNS OF MORTALITY

SEX DIFFERENCES IN MORTALITY: It has been observed that in most countries of the world, mortality conditions differ for males and females. The general experience is that females have an overall advantage over males with respect to mortality. For most countries, the average expectation of life at birth is higher for females than for males. The gap between the average expectation of life for females and males is wider in the developed than in the developing countries. In developed countries over a period of about 70 years the gap between female and male average life expectancy has widened. In most countries of the world, the crude death rates as well as the age specific death rates are higher for males than for females. There is a great deal of evidence to indicate that as far as mortality is concerned, males are at a definite disadvantage.

The phenomenon of male and female longevity has been studied by several social scientists. John Graunt, the father of demography, had observed as far back as the seventeenth century "Physicians have two women patients to one man and yet more men die than women. The question which has been investigated by some demographers is whether these differences between females and males are biologically determined or whether they arise because of the different roles played by them in society.

What are the underlying factors which are responsible for the widening gap between female and male longevity? Is it again the constitutional difference between man and woman, which equips the female with better resistance to degenerative diseases? Social scientists like Esterline and Conrad conclude that there is little to support a biological explanation of the gaps between female and male longevity. In their opinion, the reason may be traced to the different roles played by them in the society. It is pointed out that man as the breadwinner of the family has to undergo more physical and emotional stresses and strains; and therefore a great deal of his physical as well as mental energy is spent in competitive struggle to maintain a higher standard of living and achieving higher social status. It is argued that the age at retirement also presents different problems for males and females. While for the typical housewife there is practically no change in her routine and habits throughout her life time, retirement involves drastic changes in the life of the breadwinner and head of the family. He has to face a loss of status and the prospect of an inactive life. These developments have significant repercussions on his emotional and physical well being. This question regarding the longevity of females and males however has yet to be fully answered. More extensive research, covering both the biological and social aspects of the problem will have to be conducted before any firm conclusion can be arrived at.

THE AGE PATTERN OF MORTALITY: Age is an important variable in any analysis of mortality, for death rates vary with age and sex. It is for this reason that any meaningful study of mortality has to be undertaken with respect to both age and sex, and the data cross classified accordingly. The age specific



Anthropology Paper 01 - Volume 01

death rate is a measure that is most appropriate for this purpose and may be defined as the number of deaths of persons of a given age per 1,000 during a given year. The computation is similar to that of the crude death rate.

- ✓ The typical age specific mortality curve in countries of high mortality is roughly U-shaped, which indicates that mortality is very high at both the extremes of the life span, that is, in infancy and in old age.
- ✓ The shape of the age specific mortality curve of countries with low mortality is roughly J-shaped, the difference in the shape of the two curves being due to the difference in the infant mortality rate of these two countries. In countries with low mortality, the age specific mortality curve has a broader base, which indicates that low mortality rates extend over a large number of age groups. A similar pattern of the age specific mortality curve is observed for females, the only difference being that the values of the age specific death rates are lower for most of the age groups because of lower female mortality.

INFANT MORTALITY: The study of infant mortality gains importance especially because mortality during the first year of life is invariably high for all countries irrespective of whether the overall levels of mortality are high or low.

The trends in infant mortality rates of developed and developing countries indicate that some overlapping of these rates has occurred between these two regions. This phenomenon has raised an important issue regarding the utility of infant mortality rate as an indicator of social and economic development. As has been earlier observed in several countries, where infant mortality rates are similar to those of developed countries have not registered any remarkable progress in social and economic development.

- ✓ **FACTORS AFFECTING INFANT MORTALITY:** A variety of factors affecting infant mortality are customarily classified as biological and socioeconomic or environmental factors, though these two categories should not be treated as watertight compartments, for there is a great deal of interaction between the two. At times it is even possible to modify biological factors by introducing changes in socioeconomic factors. For the sake of convenience, however, these two types of factors will be discussed separately.

As has been pointed out earlier, the recent spectacular decline in general mortality has affected all age groups to some extent but the magnitude of the decline has varied at different ages. The reduction in mortality was considerably greater in the younger age groups than in the older age groups. In general it may be said that the low level of infant mortality appears to be associated with low level of general mortality.

- ✓ The level of mortality is very high in the first few hours, days and weeks of life. The reasons for infant deaths at the earlier and later stages of infancy differ to a certain extent. Hence, in a study of infant mortality, infant deaths are carefully grouped into two categories according to the age at death. The first category consists of those infants who die before they complete four weeks of life. The other category consists of those infants who die between 28 days and 365 days of their life. The rate based on the first period is known as the neo-natal mortality rate, while that on the second period is referred to as the post-neo-natal mortality rate. Factors which affect fetal and neo-natal deaths are primarily endogenous, while those which affect post-neo-natal deaths are primarily exogenous.

Biological **Endogenous Factors:** The endogenous factors are related to the formation of the fetus in the womb and are therefore mainly biological in nature. Among the biological factors affecting fetal and neo-natal infant mortality rates, the important ones are the age of the mother, the birth order, and the period of spacing between births, prematurity, weight at birth and the fact of multiple births. ?

- ✓ If a graph of fetal and neo-natal mortality rates is drawn with respect to these factors, it would more or less resemble a U-shaped curve. The maturity of an infant at birth has also been found to be an important factor affecting neo-natal and infant mortality rates. It has been observed that the weight of the baby at birth is also an important factor affecting neo-natal and post-neo-natal deaths.

✓ It may be concluded from this discussion that the causes of fetal and neo-natal deaths so far considered arise mainly out of genetic factors, and may be traced back to the intrauterine life of the fetus and to the damage occurring during the process of birth.

Exogenous Factors: Social, cultural, economic and environmental factors are also found to affect infant mortality, especially during the post-neo-natal period. Post-neo-natal deaths are therefore mainly due to various epidemics caused by communicable diseases both of the digestive system such as diarrhea and enteritis, and of the respiratory system, such as bronchitis and pneumonia, as well as by faulty feeding patterns and poor hygiene. The underlying environmental factors include crowding and congestion, unsanitary surroundings, lack of proper sunshine and fresh air, etc.

✓ Illegitimacy is also an important factor contributing to a high infant mortality rate. The difference between infant mortality rates of legitimate and illegitimate births is usually found to be quite marked. The reason for this difference is quite obvious. A child conceived and born out of wedlock is generally unwanted both by the mother as well as society. Consequently such a child does not receive the care, in terms of nutrition and other facilities that it needs.

One interesting feature of the role of endogenous and exogenous factors in determining infant mortality rates is worth noting. In countries where infant mortality rates are very low, a higher proportion of infant deaths occur during the neo-natal stage because being developed they have been successful in almost completely eliminating the environmental factors responsible for such deaths. The main causes of infant mortality in these countries are, therefore, mainly genetic or biological in nature. On the other hand in countries where infant mortality rate are high the majority of infant deaths occur after the neo-natal stage and are due mainly to environmental factors.

REASONS FOR HIGH MORTALITY IN THE PAST

Death rates all over the world were very high and fluctuating till the 19th century. The main reasons for such high mortality rates were: (1) Acute and chronic food shortages, causing famines and conditions of malnutrition; (2) Epidemics; (3) Recurrent wars; and (4) Poor sanitary conditions.

1. **Famines and Food Shortages:** In the pre-industrial phase, man had limited control over his environment, and his food supply was profoundly affected by changes in weather conditions, such as droughts, floods, severe winters and scorching summers. Agricultural production was also limited by other conditions such as inefficiency of labor, pests and by plant diseases. Even when harvests were good, food could not be stored for the future difficult times to come because of inefficient methods of storage, nor could it be transported, to scarcity areas, since easy and cheap means of transportation were not available. Besides acute famines, conditions of severe malnutrition, resulting from continuous insufficient food supply, prevailed in all countries, the state of malnutrition weakening millions of people to such an extent that they fell an easy prey to infection. Men suffering from food shortages, both in terms of quality and quantity, were unable to work efficiently. They thus lowered their own as well as their community's income.
2. **Epidemics:** Since the beginning, mankind has suffered from communicable diseases such as typhoid, dysentery, small-pox, malaria, typhus, tuberculosis, pneumonia, yellow fever, plague, etc. as well as from childhood communicable diseases such as enteritis, measles, whooping cough, scarlet fever, diphtheria, etc. All these diseases were quite common until fairly recent times, and took a heavy toll of life. These diseases tended to spread rapidly in densely situated areas through personal contacts, community use of contaminated water and food supply and as a result of the migration of persons and the movements of disease carrying flies from place to place. Until 150 to 200 years ago, scientific knowledge about diseases did not exist, and nobody understood how and why an outbreak of a particular epidemic took place and how and why it spread. Even in the seventeenth and early eighteenth centuries, a majority of the people did not receive any medical attention. Those who did had to expose themselves to such harmful methods as purging and bleeding.

Anthropology Paper 01 - Volume 01

3. **Recurrent Wars:** Throughout mankind's history, war has been an important factor affecting the population size. The effect of war on human populations is two-fold. First, death came to military personnel in the battlefield. Soldiers also died of wounds received in battle. Deaths among military personnel were also caused by deprivation and diseases associated with wars. Some wars indirectly caused heavy civilian casualties through the spread of diseases carried by armies, through plunders and various other forms of social and economic disorganization. Hans Zinsser, the eminent epidemiologist, is of the opinion that the courses of history has been shaped less by the acts of men than by chronic and epidemic diseases with which they had to contend as well as by superstitions and ignorance concerning medicine and sanitation. In the Franco-Prussian War of 1870-71, 13,000 amputations had to be performed, of which 10,000 were fatal. Napoleon was utterly helpless in his fight against typhus, pneumonia, dysentery and scurvy.
4. **Poor Sanitary Conditions:** Throughout most of mankind's history, sanitary conditions have been extremely poor. There was very little knowledge of the medical value of cleanliness. In preindustrial times, the standard of living was low: the personal hygiene of the people was inadequate and communal sanitary facilities were absent. All these factors contributed to extremely filthy environments, leading to epidemics and all kinds of diseases. Even in the early stages of industrialization, large sections of the population lived in overcrowded dark houses close to factories. These houses were poorly-ventilated, damp and lacked light and sunshine, and had poor bathing facilities and worse toilet amenities. Working conditions in factories were appalling. The concept of personal cleanliness was practically unknown. Most people not only accepted dirt and unsanitary conditions of life as being normal, but even obstructed the introduction of hygiene. Stink and nasty odors were taken for granted. The use of soap was almost unknown in the thirteenth century.

It may thus be concluded that food shortages, various types of death dealing epidemics and unsanitary hygienic conditions resulted in high levels of mortality from the beginning of the history of mankind. In recent years, however, man has triumphed to a great extent over these factors. As a result, mortality throughout the world has substantially declined.

CAUSES OF MORTALITY DECLINE IN DEVELOPED COUNTRIES

In Europe, North America and Oceania, continuous economic progress resulting from Agricultural and Industrial Revolutions, has been the main reason for the reduction in mortality rates, which first began to decline rather weakly in the seventeenth century, and then with an increasing tempo throughout the eighteenth and nineteenth centuries. In the twentieth century, mortality has continued to decline at a slower rate. Some ten factors have been enumerated as having contributed towards the reduction in mortality rates in the developed Countries.

One important development affecting mortality in European countries since the eighteenth century was the increase in the supply of food. With the Agricultural Revolution, which began in England around 1700 and spread throughout Europe and the European settlements abroad, the productivity of land and labor began to increase, the risk of crop failure was reduced and the supply of food became fairly steady. The system of rotation of crops, the development of improved strains of plants and animals, the introduction of new crops and improved farm machinery were some of the important outcomes of the agricultural revolution. With the increase in the quantity and quality of food, mortality rates in Europe and European overseas settlements came down. Further advances in agricultural technology during the nineteenth and the twentieth centuries, which included the introduction of artificial fertilizers and the mechanization of agriculture freed labor from the necessity of working on land for food production, so that they could engage themselves in different types of manufacturing activities.

With the development of the Steam engine, it became possible to transport and distribute surplus food from one area to another where scarcity conditions prevailed. The frequency of localized famines was thus arrested. Better methods of storing food also helped to mitigate the serious effects of famines.

- 3 The real income of the people gradually increased, and the availability of enough nutritious food brought about mortality declines. In fact better diet was probably the main cause of the substantial fall in mortality from tuberculosis in England and Wales.
- 4 The advances in technology and improvements in the standards of living aided the fall in mortality in many other ways. Heavy and better clothing to combat severe winters became available and health services and medical research activities were extended.
- 5 Another important factor which contributed to the reduction in the mortality was improvements in sanitary conditions and public health measures. Sanitary reforms were introduced in England in the nineteenth century following the Sanitary Reform Movement which was started to combat the many evils of the Industrial Revolution. State Governments, which had so far not taken much interest in introducing sanitary reforms, began to do so by introducing several public health measures and sanitary improvements, such public utilities for the provision of water supply, purification of water, sewage disposal, etc. By the beginning of the twentieth century, most of the cities in the Western world and Russia had developed the drainage system and provided pure and protected water. The disinfection of water by chlorination came into practice at the turn of the century, with the result that many communicable waterborne diseases such as cholera, diarrhea and dysentery were brought under control.
- 6 Social reforms in the nineteenth and twentieth centuries lessened the hazards of working in the factory early in life. Legislations bearing on the number of working hours and minimum wages was enacted, and working conditions improved because of the various safety devices that were introduced. The social security system provided benefits like old-age pensions, health insurance, medical care, unemployment insurance, etc. The introduction of free and universal compulsory schooling resulted in mass literacy and the inclusion of personal and social hygiene in school curricula helped in creating a greater awareness of the necessity of health among the people.
- 7 In the late nineteenth century, the development of asepsis (precautionary exclusion of pathogenic micro organisms) and antisepsis (killing or inhibiting the growth of micro organisms already present) helped in the reduction of mortality. Aseptic and antiseptic surgery was introduced and the germ theory was accepted in various other aspects of life such as preservation of food through pasteurization and sterilization.
- 8 The development of immunology was yet another cause of the declines in mortality. Immunization against small-pox was introduced first. This was followed by the development of vaccines for chickenpox, cholera, sheep anthrax, hydrophobia and diphtheria. Prophylactic antitoxins were also introduced against tetanus, typhoid, yellow fever, scarlet fever, poliomyelitis, influenza, Measles, whooping cough etc.
- 9 Advances in chemotherapy (use of drugs to cure or inhibit the progress of diseases) began in the late 1930s. Sulfonamides and penicillin in the treatment of respiratory and urinary tract infections came to be widely used in the control and cure of various kinds of diseases. As a consequence of the use of these broad spectrum antibiotics, mortality from communicable diseases declined substantially. After the Second World War, there have been considerable declines in mortality following the use of anti-tuberculosis drugs. The development of effective insecticides such as DDT has greatly reduced the incidence of insect-borne diseases such as typhus and malaria. Anti malaria campaigns have practically wiped out this disease from many countries. It has also indicated that there has been a change in the virulence of the disease-causing organisms and/or an increase in the resistance of the human host. Mortality from small-pox, scarlet fever and diphtheria is believed by some writers to be affected by such factors. The reason for the disappearance of one of the biggest killers, plague, from Western Europe since the middle of the seventeenth century has continued to remain a mystery.

FACTORS RESPONSIBLE FOR RECENT MORTALITY DECLINES IN DEVELOPING COUNTRIES

The rapid declines in mortality experienced by many developing countries after the Second World War have been largely due to public health and disease-control measures, which were imported from the

developed countries and therefore have been independent of economic development. These include DDT spraying, the use of antibiotics like penicillin and vaccines like the B.C.G. Scientific communication and international co-operation have made it possible for developing countries to import techniques developed by the economically advanced countries and apply them in mass public health programs at a relatively small cost. The assistance provided by the World Health Organization to eradicate such mass killers as malaria, small-pox, etc., has been helpful. Thus, though the inverse relationship between economic development and mortality continues to hold true, the link between the two has considerably weakened. It should however be noted that further declines in mortality in the developing countries will depend to a large extent on their economic development which will help them to get the maximum benefits from health programs.

MORTALITY DIFFERENTIALS: Important variations in the levels of mortality are evident for different sub-groups of the population even in the same country. For instance, the rural areas and urban areas of the same country have widely different death rates. In addition to mortality differentials by geographical residence, differentials due to other demographic and socioeconomic factors may also be observed within the boundaries of a particular country. Such factors include occupation, income level, educational attainment, sex, age and marital status.

URBAN-RURAL DIFFERENTIALS: The limited available data on this point indicates that the urban-rural differences in mortality levels are at present very small in industrialized countries. In the past however important differences in the mortality levels of urban and rural areas existed in these countries. Prior to the twentieth century, mortality was generally higher for the urban areas of many countries of Europe and North America and the differences were usually quite substantial. In the United States of America, mortality conditions in 1830 were far worse in large cities than in small cities or in rural areas. In England and Wales, the experience was similar. In 1841, while the average expectation of life for England and Wales was about 40 years, it was 35 years for London and 35 years and 24 years respectively for Liverpool and Manchester - all Industrial cities. In India, according to the Nineteenth Round of the National Sample Survey (July 1964 to July 1965), the crude death rates for rural and urban areas were 13.01 and 7.97 per thousand population respectively, indicating a lower mortality for urban India. The Sample Registration System also indicates that, for the period July 1974-June 1975, the urban and rural crude death rates were 9.6 and 16.1 per thousand of population respectively.

OCCUPATIONAL AND OTHER DIFFERENTIALS: It is now well recognized that man's surroundings and the occupation from which he earns his livelihood have an important bearing on his health habits status. The study of the relationship between a man's occupation and the risk of mortality is important from many points of view. A man's occupation is related to his education; his income depends on his occupation. Both income and education may influence his diet, his housing conditions and habits. As it is not feasible to study individually the effects of all these factors on mortality, researchers have often taken one factor as an index of all the others. The factor most studied in this context is occupation, or social status based on occupation. In England and Wales, systematic studies since 1851 have been conducted on mortality differentials based on occupational class and social class. An analysis of the data for five social classes covered in these studies indicates that in 1921-23 and 1930-32 mortality rates for males aged 20 to 64 years rose progressively from social class I (professional) to social class V (unskilled). By 1950 however a change was observed in these relationships, and males in social class II (intermediate occupations) were found to have the lowest rates' while social class IV (partly skilled occupations) however continued as before to have a substantially higher mortality than the other classes. It is obvious that persons working in different occupations are exposed to different types of risks. For instance, while workers in coal mines are more likely to suffer from tuberculosis of the lungs and lung cancer, those in sedentary occupations face the risk of heart diseases.

The educational attainment of parents, especially that of mothers, has been found to have a significant relationship with the levels of infant mortality. In Hungary a strong inverse relationship was noted between the educational status of parents and the levels of infant mortality. For infants of mothers who had never attended school, this rate was 95 per thousand births, while for those with mothers who had

thirteen or more years of schooling it was 27. In Greater Bombay it was observed in 1966 that the levels of infant mortality were highly influenced by the literacy and educational attainment of the mothers. The infant mortality rate was the highest for infants of illiterate mothers and the lowest for infants whose mothers had either passed the matriculation examination or had higher educations.

MARITAL STATUS AND MORTALITY: In countries where studies on mortality in relation to marital status have been conducted it was found that mortality rates were always lower for married males and females than for the unmarried of the same sex and age. According to demographers and sociologists, the reasons for this phenomenon may be found in the fact that marriages are selective with respect to the health status of persons for those who are healthy are more likely to get married, with the result that the risk of dying is also less. Besides, married persons are generally more secure and protected, and they usually lead a more sober life than those who are unmarried. All such factors are thought to contribute to lower mortality rates among married persons.

SOCIAL CONSEQUENCES OF MORTALITY

It is possible that the dramatic decline in mortality since the end of the 19th century has evoked some changes in social structure than any other single development of the period. However, there has been so little research that any discussion must be speculative.

Contemporary citizens of developed nations rarely encounter death, except among the aged. This situation contrasts greatly to that which prevailed in these nations formerly. In the following paragraphs it is attempted to discuss some social consequences of mortality.

1. **Changes in the Institutions of Mourning:** A seemingly direct consequence of the reduction in the frequency of bereavement is a decline in the institutions of mourning. In his book Death, Grief and Mourning, the English anthropologist Geoffrey Gorer points out that at the beginning of the 20th century there were strict rules of etiquette that the bereaved must observe toward others and that others should show toward him. At present, however, neither the bereaved nor the circle of his acquaintances knows quite how to act toward the other, and in fact a common reaction is to try to deny the very existence of bereavement.
2. **Impact on the Character of Religion:** Another apparent consequence of decline in mortality is a change in the character of religion. In their book Popular Religion, Schneider and Dornbusch point out a sharp decline in the emphasis placed on how religion will benefit one in the next world, and a marked increase in the emphasis on how religion will aid one in this world. Evidently, the intensity of popular feeling concerning an afterlife has waned. Probably a very important reason for wanting an afterlife is to reunite oneself with friends and relations who have already died. In a high-mortality society, persons of all ages have many close friends and relatives who have recently died; in a low-mortality society, only the elderly find themselves in this position. Thus mortality decline should reduce the general concern with immortality. It is also possible that extremely negative attitudes towards traditional religions may also abate with the reduction of mortality. This seemingly self-contradictory action might be based thus: supposing that the experience of prematurely losing one's parent, spouse, or child would provoke in certain individuals severe doubt that there can be a deity who is both benevolent and omnipotent, the smaller the number of persons who have such an experience, the fewer will be the number who will develop or tend to cling to extremely negative attitudes toward such a belief.
3. **Changes in the Family Structure:** A third possible consequence of mortality decline may be a change in family structure. When there is a large probability of early widowhood and orphan hood, it is hazardous for a nuclear family - i.e., a married couple and its children - to isolate itself too far from its kin group. This is because the death of either the father or the mother would make it very difficult for the orphaned children to receive proper rearing and support. Thus, in high-mortality societies we commonly see the nuclear family strongly dependent on some larger kin group. By contrast, in the low mortality developed nations of today, the nuclear family often lives at a considerable distance.

Anthropology Paper 01 - Volume 01

from other kin, and its ties with relatives, although present, are considerably weaker than they would be in a society with high mortality. In turn, the possibility of a larger number of relatively isolated nuclear families has important implications for the process of economic development. A high economic level is not possible without an elaborate division of labor, and much geographical mobility is necessary if very specialized occupational positions are to be filled by the best possible people. Hence, a high level of mortality, by impeding the possibility of a relatively isolated and independent nuclear family, also hinders the process of economic development.

4. **Changes in the Intensity of Interpersonal Ties:** A fourth possible consequence of high mortality may be reduced intensity of certain interpersonal ties. In a society wherein many children will die before reaching the age of five, parents may frequently steel themselves for the possibility of their child's early death by forbidding themselves to develop a strong emotional attachment. The same may also apply to marriage. Arranged marriages are common in high mortality societies, whereas in societies with low mortality, marriage is commonly contracted by free choice to a person for whom one has a strong emotional commitment. In a society in which a strong love relationship might soon be disrupted by death, there should be less dissatisfaction with a system of arranged marriages than in societies where mortality is low. Conversely, one may speculate that the pressure for easy divorce may increase as mortality declines, since the number of years one must expect to live jointly with one's spouse becomes so much longer.
5. **Difference in Orientation in Time:** It may be hypothesized that when mortality is high, individuals tend to have a weaker orientation toward the future and a stronger orientation toward the present than when mortality is low. If so, this may have further effects on the degree of achievement motivation in the society, since achievement always involves a sacrifice of present values for future goals. Furthermore, where mortality is high, parents may be loath to make sacrifices for the future success of their children, since the probability of the child's living to maturity is by no means certain.

- ① K is the application of man's power to the study of human life.
 Shape, composition, maturation & gross function.
 - Its purpose is to understand the human movement w.r.t growth, exercise, nutrition & performance.
 - It studies structural variation w.r.t functional aspect

Anthropology Paper 01 - Volume 01

12. APPLICATIONS OF ANTHROPOLOGY

- ② It evaluates the physical structure of individuals w.r.t. gross motor functions.

ANTHROPOLOGY OF SPORTS

① Sports have developed to be a part of human culture as recreational activities. Though these activities constitute the cultural aspects, the biological aspects of man considerably influence the performance in any sporting event. Physical factors like body size, body proportions, physique, and nutrition influence the performance. Most of these traits are acquired through heredity and are also influenced by environment to a considerable extent. Apart from this, human psychological factors like motivation, training and nature also play a vital role in molding the "sportive personality".

The above discussion makes it obvious that it requires an inter-disciplinary approach, combining human biological, cultural and psychological aspects, to understand the environment of sports. This is the foundation for anthropological role in the field of sports.

- 3 ✓ The study of sports is a specialized sub-discipline in physical anthropology. This specialization is named "Kinanthropometry". It evaluates physical structure of individuals in relation to gross motor functions. It also includes the study of such aspects as maturation, nutrition and body composition.

From first used by Bill Ross
 The term "kinanthropometry" was coined by Bill Ross in 1972. It was first considered in Olympic Scientific Congress at Quebec in 1976, prior to Montreal Olympic Games in 1978. The driving force behind most initiatives for development of kinanthropometry has been UNESCO when it founded an International Working Group on kinanthropometry at Brasilia. This working group has been working under the International Council of Sports Science and Physical Education, a division of UNESCO.

There are various factors that influence the performance of an individual in sports which depend on both heredity and environment. However, genetics has a greater role to play in the formation of a phenotype.

✓ Phenotypic variations in size, physique, body composition, metabolic powers, strength, speed and skill, cardio-vascular adaptations are governing forces behind a sportsman's performance. Environment can shape a genotype into a fit type by way of training and motivation. Kinanthropometry aims at selecting the fit genotypes which help individuals attain their fullest potentialities.

Apart from muscle strength, a sport will also need coordinated body movements. Anthropometric studies of individuals can help select players who can have better potentialities in a particular sport than others.

- 6 ✓ It has been observed that training and other extragenetic influences can change one's morphological status only within the narrow limits set by genotype. It is difficult to change the capacity of the genotype in order to maintain altered levels of different bio-chemical determinants. It is thus imperative to lay more emphasis on the genetically determined morpho-physiological status of the individual.

By making use of the techniques of kinanthropometry - a comprehensive approach to assess an individual's physique - anthropologists were able to classify humans into different somatotypes and suggest the correct sport for them. Köhlerausch made the following classification in 1929.

1. **Slender type:** Best runners, jumpers and hurdlers.
2. **Medium type:** Best boxers, ball players and swimmers.
3. **Massive type:** Best weight lifters, throwers and wrestlers.

Applications of K

- ① Growth & Dev of children
- ② Sports
- ③ Talent search in sports
- ④ Medicine

G.S. Kartic (karticsg@gmail.com)

Ex:- Redesigning of sports equipment

- ① Hockey-sticks for chota angpur boys
- ② Archery - Sauria Baharia - short stature.

both redesigned by Dr. Sachindra Narayan.

- ① Food intake, nutrition & health
- ② Pop. genetics, physiological adaptation & Nutrition
- ③ Socio-cultural processes & nutrition
- ④ Social epidemiology of nutrition
- ⑤ Relationship b/w beliefs & ideas and nutrient intake and nutritional status

(1) (b) The term NA pertains to studies for which nutrients & nutritional status of an individual (or) community are the core concerns.

Anthropology Paper 01 - Volume 01

In 1931 Arnold provided a classification of sports events and specified morphological characteristics within those types.

- Gymnast type: Individuals with relatively long bulk coupled with breadth.
- Wrestler type: Individuals with mighty forms, with great breadth of shoulders and pelvis coupled with greater depth and breadth of chest.
- Pentathlon type: Individuals with medium to slender body types with relatively longer legs and less body breadth.

The composition of body is also an important morphological characteristic to be considered for sports. The body composition is well conceived when we consider the muscular, skeletal, fatty tissues. The body composition is dependent on the environmental influence, sex, socio-economic conditions, occupation, genetic make-up, nutrition and exercise.

Body composition studies on sportsmen have great importance. It has been observed that those athletes who are less fatty but are heavy due to musculature perform better in certain competitive sports; while those with substantial amount of fatty tissue require increased energy due to inert weight, thus causing endurance in activities like jumping, running etc. But in events like swimming and other water sports, the moderate quantity of fat aids performance by providing extra buoyancy and reduction of heat loss.

Apart from physique and body composition, the favorability of one somatotype over other depends on flexibility of training, motivation factors and the psyche. Anthropology also is helpful in redesigning sports equipment to suit the particular somatotypes. Ex: Cricket bats, Rackets- Badminton, tennis.

NUTRITIONAL ANTHROPOLOGY

(see back)

of Community

- 1 ✓ Anthropology has been contributing enormously to the field of nutritional sciences. It has been especially contributing to defining the nutritional status of persons, especially by making use of the techniques of anthropometry. This area of defining the nutritional status is especially significant because the earlier methods were highly technical and were waiting for an internal consensus for their viable use. The significance of anthropological role and the underlying assumption for use of anthropometry in nutritional assessment of population lies in the fact that though heredity contributes to growth, the genotype is capable of different growth potentials in different environments. This led to the development of specialized sub-discipline within applied physical anthropology, called Nutritional Anthropometry.
- 2 ✓ Nutritional Anthropometry makes use of three basic measurements - Age, Weight and Height. By use of these three basic values, anthropologists calculate the indices and compare these indices with reference population or person.
- 3 ✓ There are basically four indices to calculate nutritional status. Each index is given a specific nomenclature.

1. Weight Height Index:

- It represents the weight of the observed person compared with that of a reference person of same height.
- This index is also called Wasting when it is deficit.

2. Height for Age Index:

- It represents the height of the observed person compared with that of a reference person of same age.
- Deficiency in this index is known as Stunting.

3. Weight for Age Index:

- It represents the weight of the observed person compared with that of a reference person of same age.
- Deficiency in this index is known as underweight.

These three indices are commonly used for nutritional assessment of children. There exists a geographical variation in the values of these indices. The fourth index, however, is also used for adults.

4. Body-Mass Index (BMI):

- This is an index of weight/height ($\frac{wt}{ht}$) in which weight is taken in grams and height in centimeters.

Nutritional anthropologists have provided indicators in terms of cut-off points to assess nutritional status.

INDICES	NOMENCLATURE FOR DEFICIT INDEX	PERCENTAGE OF REFERENCE MEDIAN
Weight - for - Height	Wasting	< 80%
Height - for - Age	Stunting	< 90%
Weight - for - Age	Underweight	< 80%

From the above table it is clear that anthropologists gave 80% as a cut-off point for weight-for-height and weight-for-age indices. However, it is 90% for height-for-age index because any serious reason for stunted growth might interfere with life. Thus the cut-off point for the index is raised.

Apart from this, anthropologists have also provided a scale of critical limits for weight-for-height index, for easy assessment of nutritional status.

Form of Malnutrition	-Weight for Height Index
Severe under-nutrition	< 60%
Mild under-nutrition	60-80%
Normal	80-110%
Mild form of over-weight	110-120%
Over weight	120-130%
Obesity	130-140%
Severe obesity	140% +

(6) NA is more applicable to the 3rd world, especially India; where malnutrition (overweight and underweight) is the core concern. It can aid in Policy making

- ① Genetic Counselling
- ② Amniocentesis & Ante-Natal diagnosis
- ③ Gene therapy - ④ Patient therapy ⑤ Embryo therapy
- ⑥ DNA fingerprinting in forensic medicine
- ⑦ Sex selection (Preferential fertilisation)

(Anthropogenetic Human Genetics concerns with principles which regulate heredity in man)

Anthropology Paper 01 - Volume 01

DESIGNING OF DEFENSE AND OTHER EQUIPMENTS

Q1 Anthropometry is the branch of physical anthropology concerned with the measurement of the human body. Anthropometric surveys provide information on the range and variation of body shape and size and they are important issues because they can significantly affect the utility of equipment, clothing, or work space.

Q2 There was a time when equipments were designed with little concern for the physical characteristic of the users. Physical anthropologists as experts of human anatomy were first involved in the designing of defense equipments during World War II. Since then anthropometric research has played significant role in engineering design of many technologies, from jet-fighter ejection seats to analyzing human posture in zero gravity based Skylab experiences.

The term Anthropometry was coined by Queslect (1871). It was however Martin, a German Scientist, who published in 1928 the famous title "Lehrbuch der Anthropologie". The revised edition of this book in three volumes, co-authored by Salter is still a significant work (1957). Knusmann (1990, 1992) has edited two volumes based on Martin's work.

Q3 Designing of any product or equipment considering human variability is a complex one, and it needs participation of three groups of people, viz. the users, the anthropologists and the manufacturers. Role of anthropologists is crucial, particularly if the efficiency of equipment is dependent on human variability. Anthropologists are supposed to provide basic data on human variability in such a simple manner that it is easy to understand and ready to apply.

Three factors that collectively determine the quality of man-machine relationship are efficiency, safety and comfort. Designs that do not consider human variations lead to poor job performance, low job-satisfaction, waste of time and increased morbidity.

Q4 **Gun Turrets:** Anthropometric data has had been very reliably taken and intelligently applied by anthropologists for Air force. It improved flying efficiency of the pilots thus saving much money on procurement of large number of pilots. After 1942, its spread to other fields of human activities has improved work efficiency by reducing discomfort of people. It is not that anthropometric data has not been used in military services, but it was primarily used for physical or medical description.

A gun-turret is a movable enclosure containing the gunner, wearing protective clothing and equipment, a pair of machine guns and a sighting mechanism. The gun turret is so designed that the gunner has all the free movement of his body needed. It has to be scientifically designed because any extrusion from an aircraft adds air-resistance. Hence, such areas as offering resistance must be reduced to minimum without compromising efficiency of the gunner.

Such improvements in US gun-turrets greatly increased efficiency of crewmen, reduced their discomfort of long occupancy in a cramped enclosure and insured effective means of escape from an aircraft in emergency, or in removal of a casualty. With the increased efficiency of crewmen, the losses to the air force were effectively curtailed.

Q5 **Cockpit Size and Seat Configuration:** Scientists have made study of cockpit space and established parameters for cockpit size in different types of air-craft. They were also instrumental in designing various seat configurations for both fighters and bombers. Such improvisation largely aided in reducing cockpit fatigue and discomfort by proper body support.

Helmets, Gloves
Oxygen masks
Garrison Partial Pressure Seats

Flight Clothing: Application of anthropometric data in the flight clothing has been vital. Individual designers have their own schedule of sizes so that clothing sometimes fit no one. Flying Helmets is one such problem. To provide correct size-control, anthropologists have sculptor-carved wooden head forms

in four statistically derived sizes extra-large, large, medium and small. Sets of these head forms are supplied to helmet manufacturers as standards.

Physical anthropologists are also concerned with designing of oxygen masks and make its correct fit with the help of a set of seven statistical sizes and shapes of sculptured face forms. Similar is the case with the garments. Body sizes of females are also taken to procure flight clothing and other garments for service women.

(6) Such anthropological efforts bring about two sided advantage - operational efficiency and economic benefits - the latter to agencies such as governments and manufacturers. Such studies indicate the vast number of sizes in which a garment would have to be fabricated, the values of dimensions necessary for each size and the number of garments required in each size.

Partial Pressure Suit

Jet Engines: Anthropometric engineering is applied in the Jet engines and it is perhaps the most important engineering program. The jets fly over altitude above 50,000 feet. At such altitudes, human body can swell up due to reduced atmospheric pressure. Dr. J.P. Henry, a medical physiologist, invented a concept called the "Partial Pressure Suit" - a one piece perfectly fitting, non-stretch garment with air tubes connected to it so that when air pressure dropped, air could be introduced in the spaces within the clothing that could prevent muscles from expanding. The unit served the purpose but there were severe sizing dilemmas. Each suit has to fit like skin from neck to wrists and ankles, but there were no anthropological data.

Once the garments are available a "fit test" is conducted and they are checked for conformity to the specified dimensions by trying them on a sample of fifty or more subjects, selected to show the full range of body size in the target population. The subject after he dons it goes through all the motions required to show whether that size actually is comfortably fit.

It was found that stature and weight generally yield the highest correlations with other bodily dimensions and could become the diagnostic dimensions for complex fitting garments. Numerous sizing programs have been tested in the forces of all the countries the world over.

The Ejection Seat and Car Passenger Safety: Originally this used to be a simple metal bucket seat mounted in the aircraft so that in an emergency, the pilot could fire the seat and himself out of the aircraft, and after freeing himself from the seat, takes to his parachute. This seat was invented by the Germans during World War II.

Any such device must take into account the centre of gravity to avoid excessive rotation of the seat as it enters the air stream at high speed. The centre of gravity is determined by the man-equipment-seat combination. Since limbs are flayed in the air, it is important to know the centre of gravity of the limbs. For such purposes, centre of gravity of limbs are known from a large sample of population. Later on, many studies were conducted for knowing moments of inertia of living subjects in a variety of fixed positions on a compound pendulum, nude and with full-pressure suit. Such data has helped refine crew accommodation in the space capsules as well as cockpits and seats of advance fighter aircrafts and automobiles. This has reduced the severity of damage during accidents.

Design Requirements: Design requirements may be classified into three groups:

- (2) ✓
- Work space design
 - Clothing and personal equipment design
 - Component and devices

Workspace design includes designing of any space for human occupancy during work, recreation, rest, education, travel, treatment etc. Designing aims to ensure that operator has adequate work space and proper location of controls, displays and devices. Designing of automobile interior, aircraft cockpits,

Anthropology Paper 01 - Volume 01

seating apparatus, doors, tunnels etc. are some of the examples where workspace designing is needed. The measurements required in designing workspace include reach limits, body clearance, eye location etc.

Clothing and personal equipment design includes designing of garments, press suits, helmets and gloves etc. The designing of such things assure proper fit and minimize restriction of movements. The body measurements that is generally required for designing clothing and personal equipment includes circumferences, body contours, limb movements etc.

Designing of components and devices include designing of small appliances such as knobs, levers, switches, handholds etc.

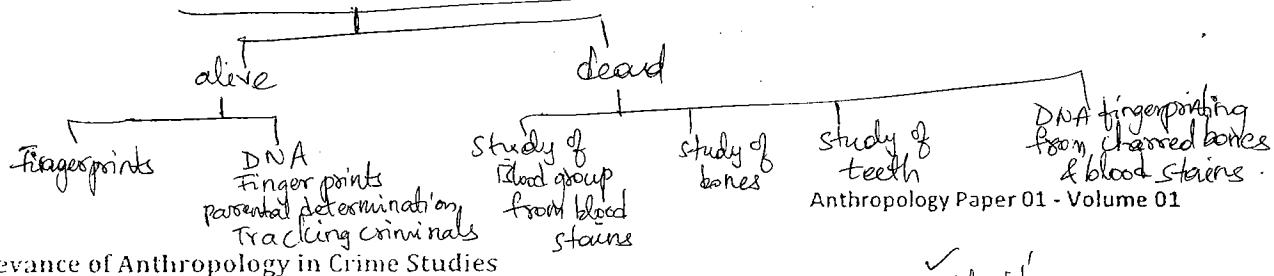
FORENSIC ANTHROPOLOGY, METHODS AND PRINCIPLES OF PERSONAL IDENTIFICATION AND RECONSTRUCTION

- 1 ✓ The term "Forensic Anthropology" implies the application of anthropological and medical knowledge to questions of law. This science is used in detection of crime. The term comes from the Latin word "Forensis" which means "Court of Law".
- 2 ✓ Forensic anthropology is an applied specialization within physical anthropology. Physical anthropologists, with their insight into the human anatomy would be able to contribute considerably in the field of crime. Forensic anthropology, as an applied discipline in physical anthropology, was recognized by C.C. Show in 1972, and he defines the role of physical anthropologist as "a person with specialized knowledge of human sexual, racial, age and individual variations to the problems of medical jurisprudence".
- 3 ✓ The two most important aspects of Forensic Anthropology are...
 1. The identification of decomposed or mutilated bodies.
 2. Analysis of skeletal and fragmentary remains.

According to Chaurasia, the Forensic Anthropologist tries to answer the following questions while analyzing the remains at the crime scene.

1. Whether the bones are human or non-human?
2. Whether they belong to one or many humans?
3. What would be the sex?
4. What is the age?
5. What is the race of the person?
6. What is the cause of death?
7. What is the time of death?
8. What are the other distinguishing characteristics in the skeletal remains that may lead to personal identification?

- 5 ✓ The evidences for the Forensic anthropologist to work include bone, teeth and personal belongings, finger prints. Apart from this, the Forensic anthropologist makes use of his techniques in genetics (e.g., DNA Fingerprinting) to identify the victim as well as the culprit. Even the trivial proportions of Saliva, Semen, blood or scratches of skin tissue can come handy for Forensic anthropologist to identify the persons involved.



Relevance of Anthropology in Crime Studies

✓ An anthropologist is an experienced specialist in the field of comparative anatomy. Their knowledge in the field of understanding human evolution and non-human primates has been of considerable help in the field of crime analysis. Their specialization in understanding racial affiliation, construction of a stature from broken bones and assessment of understanding postmortem skeletal alteration helps crime studies for a positive identification. Apart from this, an anthropologist's specialty in excavation techniques and mapping, have made a considerable change in field of evidence recovery.

✓ Forensic anthropology, as a specialized field of physical anthropologist, made a considerable progress since last three decades. Much of its growth depends on new developments in its methodological areas. There is a growing need for associating anthropologists in field of evidence discovery and recovery in the modern world and this trend continues to grow in the near future.

PERSONAL RECONSTRUCTION AND IDENTIFICATION

→ Definition (?)

(1) IDENTIFICATION OF SEX

Sexual dimorphism in the pelvic girdle of the female is seen owing to the natural selection of birth process and larger heads during birth.

(a)

Pelvic Girdle

	Typical Male	Typical Female
Sub Pubic Angle	< 90 Degrees	> 90 Degrees
Pubic Shape	Triangular	Rectangular
Sub Pubic Angle Shape	Convex	Concave
Greater Sciatic Notch	< 68 Degrees	> 68 Degrees
Sacrum	Small & Curved	Large & Straighter

Males are usually larger and have more rugged areas for muscle attachments than do females of the same species. However, populations differ in skeletal size and robusticity - Asian Indians are smaller and more gracile than Australian aborigines.

(b) DIMORPHISM IN CRANIUM

Cranium	Typical Male	Typical Female
Muscle Attachment Areas	More Pronounced	Less Pronounced
Supra Orbital Torus (Ridge)	More Pronounced	Less Pronounced
Frontal Bone	Slanting	Globular
Supra Orbital Rim	Rounded	Sharp
Palate	Deep	Shallow

② DETERMINATION OF AGE

- During growth, the skeleton and dentition undergo regular changes that allow the determination of age at death

(a) Dental Eruption

- The determination of ages at which the deciduous and permanent dentition erupts is useful in identifying age to approximately 15 years
- The third molar (wisdom tooth) erupts after this time, but is so variable in age of eruption (if it erupts at all) that it is not a very reliable age indicator

(b) Bone Growth

✓ Postcranial bones are preceded by a cartilage model that is gradually replaced by bone, both in the primary growth centers (diaphyses) and in the secondary centers (the ends of the bones, or epiphyses)

- The initial ossification centers are very small, and are only rarely encountered by forensic anthropologist

✓ The bone continues to grow until the epiphyses fuse with diaphyses

✓ Because this fusion occurs at different times in different bones, the age of an individual can be determined by which epiphyses have fused and which have not

- The characteristic undulating appearance of the unfused surfaces of bone helps differentiate it from the mature long bone (smooth) or merely a broken end of a bone (sharp and jagged)

✓ Females mature more quickly than males, so usually 1 to 2 years must be subtracted from the ages

✓ Once a person has reached physiological maturity (by early 20s), the determination of age becomes more difficult

- Several techniques are used, including

- Progressive changes in the pubic symphyseal face (the most common technique) in sternal ends of the ribs

- Ectocranial (outside the cranium) and endocranial (inside the cranium) suture closures

- Cellular changes determined by microscopic examination of the cross section of various long bones

✓ Degenerative changes, including arthritis and osteoporosis, can aid in the determination of relative age, but should not be used by themselves, as injury and certain diseases can cause changes that mimic old age in bones



Pubic Symphyseal Face

- The pubic symphyseal face in the young is characterized by a surface with ridges and furrows but undergoes regular metamorphosis from age 18

- By mid-30s it has a more finely grained face and perhaps still containing remnants of the ridge and furrow system

By mid 50s-60s - there will be ^{bony} outgrowths which often develop on ^{bony} orderings of symphyseal face.

Relevance of Anthropology in Crime Studies

An anthropologist is an experienced specialist in the field of comparative anatomy. Their knowledge in the field of understanding human evolution and non-human primates has been of considerable help in the field of crime analysis. Their specialization in understanding racial affiliation, construction of a stature from broken bones and assessment of understanding postmortem skeletal alteration helps crime studies for a positive identification. Apart from this, an anthropologist's specialty in excavation techniques and mapping, have made a considerable change in field of evidence recovery.

Forensic anthropology, as a specialized field of physical anthropologist, made a considerable progress since last three decades. Much of its growth depends on new developments in its methodological areas. There is a growing need for associating anthropologists in field of evidence discovery and recovery in the modern world and this trend continues to grow in the near future.

PERSONAL RECONSTRUCTION AND IDENTIFICATION

IDENTIFICATION OF SEX

Sexual dimorphism in the pelvic girdle of the female is seen owing to the natural selection of birth process and larger heads during birth.

Pelvic Girdle	Typical Male	Typical Female
Sub Pubic Angle	< 90 Degrees	> 90 Degrees
Pubic Shape	Triangular	Rectangular
Sub Pubic Angle Shape	Convex	Concave
Greater Sciatic Notch	< 68 Degrees	> 68 Degrees
Sacrum	Small & Curved	Large & Straighter

Males are usually larger and have more rugged areas for muscle attachments than do females of the same species. However, populations differ in skeletal size and robusticity - Asian Indians are smaller and more gracile than Australian aborigines.

DIMORPHISM IN CRANUM

Cranium	Typical Male	Typical Female
Muscle Attachment Areas	More Pronounced	Less Pronounced
Supra Orbital Torus (Ridge)	More Pronounced	Less Pronounced
Frontal Bone	Slanting	Globular
Supra Orbital Rim	Rounded	Sharp
Palate	Deep	Shallow

Anthropology Paper 01 - Volume 01

DETERMINATION OF AGE

- During growth, the skeleton and dentition undergo regular changes that allow the determination of age at death

Dental Eruption

- The determination of ages at which the deciduous and permanent dentition erupts is useful in identifying age to approximately 15 years
- The third molar (wisdom tooth) erupts after this time, but is so variable in age of eruption (if it erupts at all) that it is not a very reliable age indicator

Bone Growth

- Postcranial bones are preceded by a cartilage model that is gradually replaced by bone, both in the primary growth centers (diaphyses) and in the secondary centers (the ends of the bones, or epiphyses)
- The initial ossification centers are very small, and are only rarely encountered by forensic anthropologist
- The bone continues to grow until the epiphyses fuse with diaphyses
- Because this fusion occurs at different times in different bones, the age of an individual can be determined by which epiphyses have fused and which have not
- The characteristic undulating appearance of the unfused surfaces of bone helps differentiate it from the mature long bone (smooth) or merely a broken end of a bone (sharp and jagged)
- Females mature more quickly than males, so usually 1 to 2 years must be subtracted from the ages
- Once a person has reached physiological maturity (by early 20s), the determination of age becomes more difficult
- Several techniques are used, including
 - Progressive changes in the pubic symphyseal face (the most common technique) in sternal ends of the ribs
 - Ectocranial (outside the cranium) and endocranial (inside the cranium) suture closures
 - Cellular changes determined by microscopic examination of the cross section of various long bones
- Degenerative changes, including arthritis and osteoporosis, can aid in the determination of relative age, but should not be used by themselves, as injury and certain diseases can cause changes that mimic old age in bones

Pubic Symphyseal Face

- The pubic symphyseal face in the young is characterized by a surface with ridges and furrows but undergoes regular metamorphosis from age 18
- By mid-30s it has a more finely grained face and perhaps still containing remnants of the ridge and furrow system

Anthropology Paper 01 - Volume 01

- By mid 50s and 60s, there will be bony outgrowths often developing on the outer rims of the symphyseal face
- This was developed by T.W. Todd, McKern and Stewart

(3) DETERMINATION OF RACE

- Racial identification is usually difficult because for many traits there is more variation within races than between races

FEATURE	NEGROID	CAUCASOID	MONGOLOID
Incisors	Blade	Rarely Shoveled	Shoveled
Cranial Shape	Dolicocephalic	Mesocranial	Brachycephalic
Nasal Root	Wide, Rounded	Narrow, Pinched	Medium, Tented
Nasal Aperture	Platyrrhiny	Leptorrhiny	Mesorrhiny
Zygomatic Bone	Medium	Retreating	Projecting
Ear Opening	Round	Round	Oval
Facial Shape	Prognathic	Orthognathic	Medium

(4) ESTIMATION OF STATURE

✓ Stature is usually calculated by measuring the length of long bones by Trotter, Gleser and Genoves. Because these formulae are derived for each sex of various racial groups, the sex and race of the unknown individual must be known before formulae can be reliably applied.

Femur Length (mm)	Stature (cm)
452	169
456	170
461	171
465	172
469	173

(Data drawn from White Males with known stature at time of death)

① DNA profiling (pg - 150)

Anthropology Paper 01 - Volume 01

② PHOTO SUPERIMPOSITION

- Photo superimposition is employed when a probable identification has been made
- The skull is superimposed onto a photograph of the known individual
- If enough landmarks fall on the same position on the skull and on the photograph, the forensic scientist has made a identification
- This technique is also used to reinforce the decision made in some of the cases

③ FACIAL RECONSTRUCTION IN HUMAN IDENTIFICATION

- Facial reconstruction, also termed facial reproduction is a process used when other identification procedures have been unsuccessful
- Two different methods of producing a face on the skull are employed
 - A portrait of the individual using clues from the bones of the face
 - A more direct 3D method of applying clay to the skull
- These techniques employ both science and art
- The physical anthropologist discovers the age, sex and race of the skull, but there is no direct evidence from bone that indicates the eye color, hair color and style, lip form, or degree of wrinkling or fleshiness in the individual
- There is a great deal of subjectivity in the rendering of the finished product,
- An exact reproduction is however not expected and only a likeness is achieved
- Erasers or blocks of clay marking tissue depths are commonly glued to the skull (depths are arrived at experimentally from cadavers)
- Clay strips, graduated to the various tissue depths, then "fill in the dots" between erasers and the face is "fleshed out"
- The eyes, nose and sometimes ears are then fashioned according to various guidelines, and a wig is usually added
- If required, features for aging are also added

APPLIED HUMAN GENETICS

Need
- ① Theft of babies from hospitals
- ② Illicit & extramarital born kids
- ③ Rape & pregnancy issues

PATERNITY DIAGNOSIS

- A parentage test is conducted to determine whether two individuals have a biological parent-child relationship. A paternity test establishes genetic proof whether a man is the biological father of an individual, and a maternity test establishes whether a woman is the biological mother of an individual.
- DNA analysis (known as genetic fingerprinting of individuals), offers a more reliable way to determine the genetic parent, although older methods have included ABO blood group typing, analysis of various other proteins and enzymes, or using HLA antigens. The current techniques for paternity testing are using polymerase chain reaction (PCR) and restriction fragment length polymorphism (RFLP).

DNA testing is currently the most advanced and accurate technology to determine parentage. In a DNA parentage test, the probability of parentage is 0% when the alleged parent is not biologically related to

Parent Plant group	progeny	impossible
A, A	A, O	AB, B
B, B	B, O	AB, A
A, B	A, B, AB	O
O, O	O	A, AB, B

P1 \rightarrow Typing of alleles F1

- If individual has D then Rh+ve



Anthropology Paper 01 - Volume 01

the child and the probability of paternity typically greater than 99.9% when the alleged parent is biologically related to the child. More information on DNA Profiling is already presented in the relevant topic in this volume.

Postnatal DNA testing:

- Blood collection and testing
- Buccal swab (cheek swab) collection and testing
- Umbilical cord collection and testing
- Other sample collection and testing (semen, tissue, hair, etc.)

Prenatal DNA testing:

- **Amniocentesis:** This test is performed in the second trimester, anywhere from the 14th-20th weeks of pregnancy. During this procedure, the doctor uses ultrasound to guide a thin needle into the uterus, through the abdomen. The needle draws out a small amount of amniotic fluid, which is tested. Risks include a small chance of harming the baby and miscarriage. Other side effects may include cramping, leaking of amniotic fluid, and vaginal bleeding.
- **Chorionic Villus Sampling (CVS):** This test consists of a thin needle or tube which a doctor inserts from the vagina, through the cervix, guided by an ultrasound, to obtain chorionic villi. Chorionic villi are little finger-like pieces of tissue attached to the wall of the uterus. The chorionic villi and the fetus come from the same fertilized egg, and have the same genetic makeup. This testing can be done earlier in pregnancy from the 10th-13th weeks.

GENETIC COUNSELING (page - 148)

It examines the symptomatic treatment of genetic diseases.

EUGENICS, EUTHENICS, EUPHENIC

is the process of improving the defective genetic material in genetic character.

Ex:- Gene therapy, stem cell, recombinant

Eugenics may be considered to be the social attitude that aims at improving the quality of future genetic constitutions by restraints of production. This goal has been the plea of many well known geneticists. Common sense dictates that persons endowed with good or desirable qualities of body, mind and social attitudes should populate the earth at a greater rate, while those with inferior traits should desist from adding to the load of deleterious genes. However, the difficulty and the danger in using planned mating to improve the human race arise because of the fundamental uncertainty as to what constitutes an improvement. The specifications for what may be regarded as "superior" qualities are likely to be highly subjective. 8. It also raises many ethical & legal issues

✓ 1. Eugenics deals with the application of the laws of genetics to the improvement of human race. The term "eugenics" was coined by an English scientist Francis Galton in 1885. The science of eugenics can also be defined as a science of well born, improving the inborn qualities of race and obtaining the better heritage by judicious breeding.

✓ 2. **Eugenics and Euthenics:** The betterment of human society can be achieved by following two inter-related methods:

1. By one of the method we can deal with the already existing human beings. The improvement of already existing human beings can be achieved by improving the environmental conditions, e.g., by subjecting them to better nutrition, better unpolluted ecological conditions, better education and sufficient amount of medical facilities. This type of method of improving the human race is known as "Euthenics".

- Easy enumeration of chromosomes - enabled to identify numerical & structural aberrations
- Down syndrome (congenital disorder) - Trisomy-21
- Turner's, Klinefelter's

Anthropology Paper 01 - Volume 01

2. By another method, we can improve the future generations by improving the germplasm of existing individuals. This type of method is known as "Eugenics". Eugenics believes in artificial selection of physically and mentally sound individuals and discouragement of defective individuals for the inheritance of their defective germplasm to the future generations. In other words, eugenics seeks the measures to preserve the best type of germplasm and to eliminate defective germplasm from the human society by applying the laws of inheritance to man.

Basis of Eugenics: The science of eugenics roots largely in the fact that the human being is an animal subject to the same laws and principles that govern the rest of the animal kingdom. It has been observed that the basic genetic mechanism of man, mice, higher plants and molds appear to be the same and in principle, the genetics of man is not unlike the genetics of a virus.

For a long time, man was considered a peculiarly awkward object of genetic investigation because his long life cycle and comparatively small individual progenies are indeed unfavorable to the use of certain standard research techniques of the geneticists. Moreover, we are neither able to subject ourselves to rigorous experimental conditions nor do we desire to do so. In the standard genetic approach, closely controlled mating and standardized environment are prerequisite. Where man is concerned, these experimental ideas are not feasible. Taking into consideration of above mentioned difficulties, the geneticists evolved the technique of studying the family known as "pedigree analysis", which we shall discuss eventually in this chapter.

Need for Eugenics: The development of all organisms including the human individuals depends on both heredity and environmental factors. For the best development, good heredity and good environment are essential. Even in the best environment there is little possibility for change of defective hereditary traits. The need of eugenics is apparent from the stand point of education, sociology and civilization. The aim of geneticists should be of increasing the normal and gifted population and at the same time decreasing the abnormal and deficient populations.

Eugenics and Human Betterment: Both hereditary and environmental factors play a significant role in the development of the organisms. For better type of development, both good hereditary and suitable environment are necessary. When we consider the future welfare of the human race then the following two factors alarm us greatly:

1. The declining birth rates are among the normal and superior people (those having best germplasm)
2. A relative rapid increase of the abnormal and defective individuals (those having defective germplasm).

For the betterment of future generation, it is necessary to increase the population of outstanding people and to decrease the population of abnormal and defective people by applying the principle of eugenics. Eugenics can be applicable by adopting following two methods.

- a) By encouraging the marriages between desirable persons.
- b) By discouraging the marriages between undesirable persons.

A) Positive Eugenics: The positive eugenics attempts to increase consistently better or desirable germplasm and thus to preserve best germplasm of the society. The percentage of desirable traits can be increased by adopting following measures:

1. **Early marriage of those having desirable traits:** It is most commonly observed fact that the highly placed persons of the society often have great ambitions for the future life. In achieving their ambitious goals, they often devote the best part of their youth and they are able to marry in late age (i.e., 30 to 35 years). The biological and psychological investigations have revealed that the aged persons often lack in necessary amount of emotional warmth for the sexual activities and

moreover, their germplasm also loses its vigor. Therefore, some laws should be formulated to prevent the late marriages of highly endowed persons by applying high taxation on them and at the same time, the young persons having the best hereditary traits should be encouraged for early marriages.

2. **Subsidizing the fit:** Because the highly endowed persons lead a well planned life and, to avoid unnecessary difficulties in nursing the children, they often prefer to have small number of children. Therefore, the selected young men and women of best eugenic value should be encouraged to increase their birth rate. Moreover, H.J. Muller has suggested that such persons not only should increase their family size but through artificial insemination, the outstanding man can serve as fathers to many more children than would be otherwise possible. Artificial insemination is already widely practiced to permit those women whose husbands are sterile or have some serious hereditary afflictions to bear children. The sperms and eggs of outstanding persons can be stored for future use by quick freezing and storing them in deep freeze. These germ cells thus can be stored for 100 or more years. Very recently the scientists felt the urgent need of establishment of sperm and egg banks to protect these precious germ cells from radiation. The germ cells could be collected during early adulthood and stored in lead lined containers in the deep freeze. In this state, the germ cells would not be subjected to radiation exposure.
3. **Education:** In a society, the people should be educated about the basic principles of human biology, human genetics, eugenics and sex. The children should be instructed about basic laws of health and they should be encouraged to develop a physically and mentally healthy body. Moreover, sex should be free from the wide spread confusion, narrow minded concepts and religious and ethical bindings. The children ignorant about the facts of sex may do more harm to society than otherwise.
4. **By avoiding germinal waste:** The wastage of best type of germplasm can be avoided by adopting following measures:
 5. The selection of marriage partners should be made with intelligence.
 6. The social hindrance which does not allow the teachers, nuns and priests to get married, must be removed. By adopting such measures the wastage of best type of germplasm due to lack of opportunities can be prevented.
 7. Wars must be avoided because in wars the best germplasm of the society is wasted.
 8. **Genetic counseling:** Genetic counseling can do great benefit to human society. The role of the genetic counselor is to inform concerned individuals of the nature of mutant condition that concern them. If it is inherited in a Mendelian fashion, then the probability of producing affected offspring can be calculated. The final decision for taking a risk is entirely the responsibility of the individual involved. It cannot be made by the counselor.
 9. **Improvement of environmental conditions:** Both heredity and environment have inter-related role in the development of eugenically better persons. Therefore, every person should get better food, living conditions, education and medical guidance, etc., so his or her hereditary traits can do their best development.
 10. **Promotion of genetic research:** Our knowledge about genetics is not sufficient enough because we still have little information about various human disease and metabolic disorders which are generally related with the genes. Therefore, the research in the field of cytogenetics should be increased so that we can learn more and more about the man.

B) Negative Eugenics: Negative eugenics attempts to eliminate the defective germplasm of the society by adopting following measures:

1. **Sexual separation of the defective:** Defective persons may have various sex-linked diseases such as night blindness, hemophilia, color blindness, etc., and various other defective traits which

- ① Production of proteins in abundance ex: Insulin, Growth Hormone.
- ② Molecular analysis of diseases ex: sickle-cell anaemia, Thalassemia
- ③ Laboratory diagnostic applications ex: AIDS
- ④ Pre-natal diagnosis of diseases ex: sickle cell anaemia using DNA probes
- ⑤ Application to forensic medicine ex: Parenthood, Criminals by DNA fingerprinting, applying Southern blot technique.
- ⑥ Gene Therapy
- ⑦ Industrial applications ex: Producing sugar, cheese, detergents may be regulated by dominant or recessive genes. The increase of germplasm of the persons having such defective traits in the population can be checked by keeping them away and separated from the society.

- ⑧ Agriculture applications ex: resistance to drought, diseases; high yield
- ⑨ Transgenetics - Transfer of genes into fertilised ovum
- ⑩ Evolution :- Bridges several missing links in the evolution (by amplifying DNA - by PCR) from archaeological samples of extinct animals.

Anthropology Paper 01 - Volume 01

2. **Sterilization:** Sterilization is the best means to deprive an individual from his power of reproduction without interrupting with any of his normal functions. Sterilization is based on surgical operation of sperm duct or vas deferens in males and oviducts or fallopian tubes in females. The former is known as vasectomy and the later is splenectomy or tubectomy. The family planning movement in India has adopted the sterilization as the tool for controlling the rate of vastly increasing population and in that case, sterilization is eugenical in its application than eugenic.
3. **Control of immigration:** Through immigration there are enough chances that undesirable or defective genes of different races and nationalities may intermingle with the normal germplasm of the populations. Therefore, the immigration rules must be strict and the persons with undesirable hereditary traits must not be allowed to migrate from one place to another.
4. **Regulation of marriage:** Presently, most human societies are money-minded and for the marriage relationship, the wealthy or highly placed persons which, however, may contain several defective genetic traits, are more preferred than those which have eugenically sound hereditary traits but having no money and which fail to reach to highest status of the society due to lack of opportunities. Some rules must be enacted to encourage the marriages among desirable mates.

~~DNA TECHNOLOGY IN DISEASES AND MEDICINE~~

DNA technology has made a significant contribution in all the three spheres of medicine - prevention, diagnosis and treatment. The various techniques in this method are discussed.

Muscular dystrophy, Huntington's disease etc... can be identified by DNA probes

1. **DNA Probes:** DNA probes are short segments of DNA that recognize complementary sequences in DNA and thus allow identification of specific DNA sequences. This method is especially useful in diagnosis. DNA probes can hybridize with specific DNA sequences and allow the identification of viruses, specific parasite. Earlier, the identification of a parasite required the culture of blood or stool sample in different media. But with development of this technique, the identification of the parasite is easily accomplished. DNA probes have been developed for Leishmania, Trypanosoma, Plasmodium, Schistosoma, Wuchereria and other human parasites; DNA probes can also be used to identify viruses which were earlier difficult to culture. Recently for TB - Gene Xpert

Gene replacement

2. **Gene therapy:** The method of gene therapy is already discussed in the chapter on Human Genetics. It is especially useful in introduction of functional genes in individuals suffering from non-functioning of some of their genes.

(most common)

by recombinant technology

3. **Production of Hormones and Proteins:** DNA technique is today used for elaboration of many hormones and proteins. Earlier, these were obtained from various types of animals by killing them. Today, with DNA technique, the genes responsible for their production can be introduced into bacteria by vectors. These genetically altered bacteria produce greater amounts of these substances. Hormones like insulin, growth hormone, proteins like urokinase are industrially produced today using this technique.

4. **Production of Synthetic Vaccines:** The conventional vaccines are inactivated germs or their antigens. The use of such vaccines always has a danger of contamination. Synthetic vaccines are produced by separation of pure antigens using mono-clonal antibodies. These are specific antibodies produced by Lymphocytes when they hybridize with the concerned cell. The resulting hybridoma (of Lymphocyte and the cell) can synthesize antibodies continuously. Such antibodies can be used for diagnosis, therapy and also prevention. Synthetic vaccines can also be produced by transferring genes for certain antigens into bacteria. Bacteria produce antibodies in large quantities which can be used as vaccines. The vaccine for Hepatitis virus is manufactured this way.