Chap # 17

Selection and evolution

Phenotypic variation is due to :

=> Genetic factors

=> Environmental factors

=> Combination of genetic and environmental factors.

Genetic factor is due to genetic variation of independent variation, crossing over and mutation.

Environmental factor : A plant has a potential to grow, but if it is not supplied with enough sunlight and minerals, it will not grow.

=> May induce mutation

=> Temperature and change in animal colour

=> UV light and melanin production

=> effect usually greater on polygenes

Discontinuous variation:

=) Discrete and distinct phenotype

=) No range of phenotype.

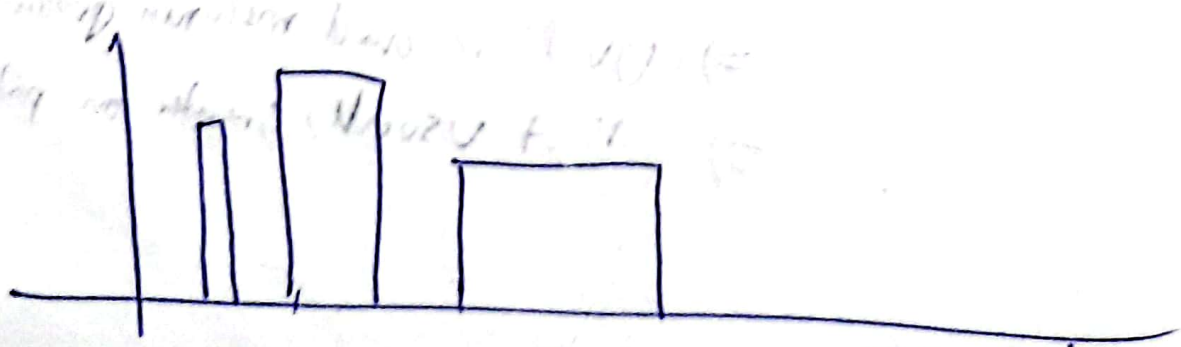
=) no intermediates

=) affected only by one gene,

=) Different alleles at a single gene locus have large effect on the phenotype.

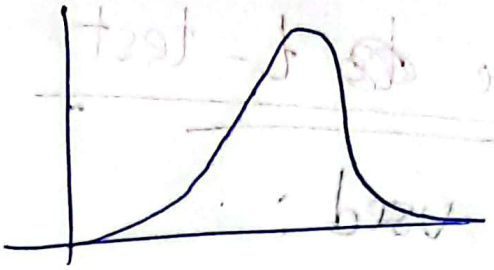
=) Not affected by environment.

=) only due to genetic factors.



Blood group, HBD allele, etc

Continuous Variation



=) Range of phenotypes.

=) Normal Distribution

=) Environmental effect ; nutrients, light, soil, water ... pH.

=) Large number of genes may have a combined effect on the particular phenotype .... Polygens.

=) The polygenes have the same effect on the phenotype, additive effect.

=) Different alleles at a single gene locus have as small effects on the phenotype.

The t-test

is used:

=) To determine whether there is a significant difference between means of two different groups.

=) Data should be

- continuous
- normally distributed

---

(1) State null hypothesis (H.)

=> there is no significant difference between the means of the two groups we are comparing

(2) Calculate t- value

$$t = \frac{|X_A - X_B|}{\sqrt{\left(\frac{S_A^2}{n_A} + \frac{S_B^2}{n_B}\right)}}$$

X = mean

S = SD (standard deviation)

n = sample size.

(3) Calculate degree of freedom

$$\# df = (n_A + n_B) - 2$$

(5) find Critical t- value from t-distribution table at 0.05 probability

(*) Critical t value > Calculated t- value ($p > 0.05$)

~~Null~~ Null accepted

(*) Critical t-value < Calculated t-value ($p < 0.05$)

Null rejected

Why Variation is important?

⇒ Variation means the presence of different characteristics or phenotype.

⇒ Resulting in different survival rate.

⇒ leads to reproductive failure or success.

Allele frequency can change by three events: (i) Natural Selection
(ii) Genectic drift
(iii) founder effect.
(iv) Mutation
(v) Migration

Natural ~~Sel~~ Selection

There is a variations in population, which ~~caller~~ results in unequal chances of survival. Some can have beneficial alleles that increases the chance of surviving and reproducing. They are said to have selective advantage

Why ~~nat~~ natural Selection is important?

=) Population have the capacity to produce many offspring.

=) that ~~compt~~ compete for resources.

=) ~~Reputator~~ Populations have many variations.

=) in the struggle for existence, (carrying beneficial alleles)
individuals that are best adapted are most likely to survive and reproduce

) So pass on their alleles to next generation.

When a population is increased, environmental factors like : Biotic factors [predation, infection, competition

Abiotic factors (water supply and nutrients (gas) in soil)

~~Cause~~ reduce the growth ~~of~~ or affect population.

Natural ~~sect~~ selection :

=) There is range of individuals in a population ~~which have~~ due to variations

=) ~~Indiva~~ Individual in the population have great reproductive potential.

=) ~~genetic~~ variation affects the (particular) phenotype in the member of population.

=) Environmental factor (~~of~~ ~~destabilic~~ ~~or~~ ~~of~~ abiotic, biotic) acts as a selection pressure. (Specify according to question)

=) ~~Spont~~ Random mutation produces ~~an~~ the beneficial allele.

⇒ Cause many fail to survive.

⇒ those with best adapted (with having beneficial allele) can survive due to their selective ~~advanta~~ advantage → phenotypes) came from mutation.

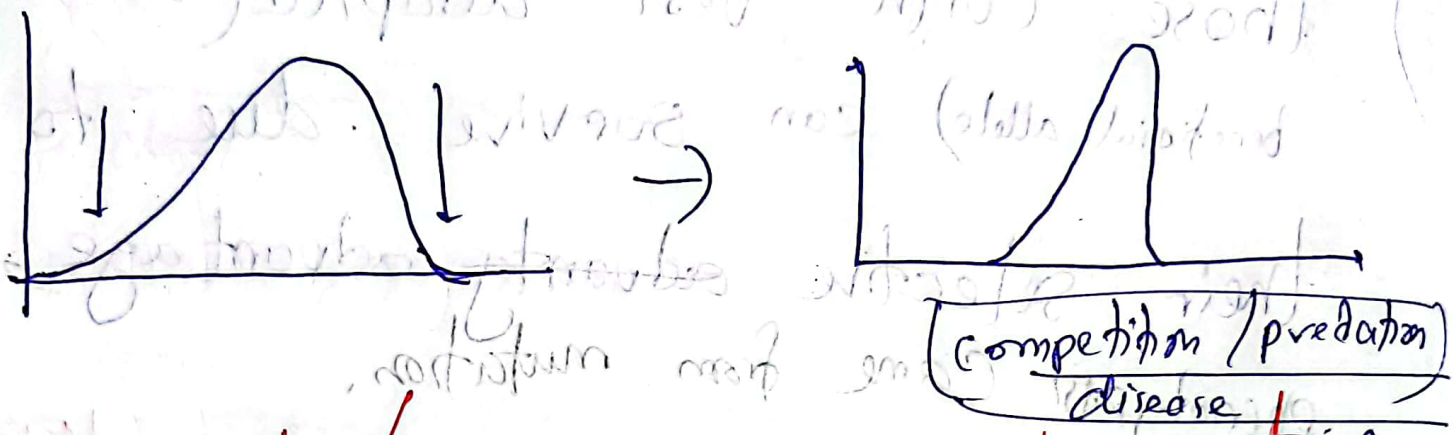
⇒ reproduce to pass on alleles to their offspring.

⇒ genetic variation can occur due to mutation. (by directional selection) → can lead to evolutionary changes

⇒ increase of the ~~change in~~ allele frequency

Environmental factor as Stabilising force of natural selection, How??

=>



=> Constant / unchanging environment

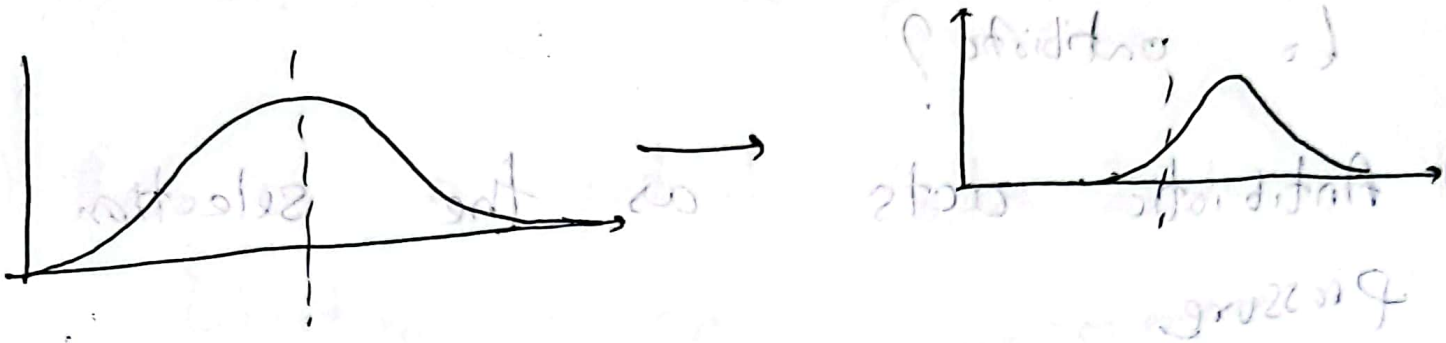
=> ~~as~~ acts as a selection pressure to the conditions

=> those best adapted can survive, intermediate phenotypes.

=> Extreme phenotypes are selected against so do not survive.

=> keeps allele frequency relatively constant over generation.

Directional Selection :



=) natural selection that causes gradual change in allele frequency over many generation.

=) Single phenotype is favoured.

=) Can occur due to mutation.
so new allele appears

=) Can bring evolutionary changes.
(Allele adaptive spread)

=) If new allele arrive or environment changed ... acts selective advantage or selection pressure.

Has bacteria can evolve to become resistant to antibiotic?

⇒ Antibiotic acts as the selection pressure

⇒ Bacteria has chance of mutation

⇒ Mutation can caused the formation of allele that coder for

⇒ antibiotic resistance, the selective advantage.

⇒ So the mutant bacteria survive and reproduce

⇒ passing the allele coder for antibiotic resistance

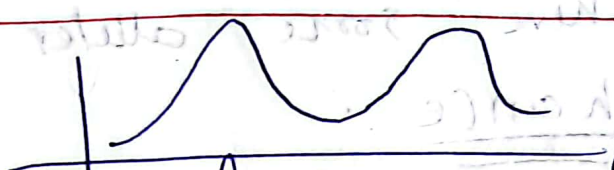
⇒ to their offspring

=) They reproduce by binary fission

=) this is a natural selection and Directional Selection.

- selection pressure
- mutation
- selective advantage

Disruptive selection:



=) maintains relatively ~~high~~ high frequency of two different ~~mains~~ sets of alleles

=) intermediates selected against and extremes ~~sel~~ selected for.

=) alleles for extreme phenotypes are more likely to survive and ~~pass~~ reproduce.

=) maintains polymorphism

=) diversifying selection.

Genetic Drift: → in small population

↳ the gradual change in allele frequency in a SMALL POPULATION, where some alleles are lost by chance. of few ones

⇒ effect of genetic drift in large is usually negligible, as there are many alleles ⇒ show no trend in result.

⇒ Bottle neck effect

↳ When ~~size of~~ number of species ~~severely~~ severely reduced result in loss of a large number of alleles

* thus reduction in gene pool/allele frequency of the specie.

FounDER Effect

=) Reduction in gene pool / allele frequency

=) compared with the main populations of species

=) resulting from two or three individuals

=) starting off a new population.

=) The founder carry ~~only a~~ only a small fraction of the total genetic variation of the parental population.

Hardy-Weinberg Principle:

It is used to calculate

~~Ate~~

Allele
Genotype
Phenotype

Frequency in a population

When a certain criteria are ~~fullfill~~ fulfilled.

1) No mutation

No change to the type of alleles available for a gene in the population.

2) No natural selection.
Significant selective pressure against one of the genotypes.

3) The ~~polut~~ population is infinitely large.

4) All members of the populat
Breed sexually.
~~no no random no~~

5) All ~~random~~ mating is rand

6) There ~~n~~ no is migration in or out of the population.

7) Organisms must be diploid

All criteria ~~fulfi~~ fulfilled ~~are~~ ensures ~~that~~ equilibrium

(B) (b)

$$P + q = 1$$

P = frequency of the dominant allele

q = frequency of the recessive allele.

Example: 50 fisher in a population.

Alleles: B: Black

b: white

B = 60

b = 40

homozygous dominant: BB => 18 → 18 × 2B = 36 BB

Heterozygous ~~recessive~~ Bb => 24 → 24 × 1B = 24

homozygous recessive: bb => 8 → 2 × 8 + 24 = 40

Total allele = 2 × 50 = 100

b = 0.4

B = 0.6

~~0.4 + 0~~

0.6 + 0.4 = p + q = 1

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

p^2 => frequency of the homo zygous dominant individuals.

(BB)

2pq => frequency of the hetero zygous dominant individual.

(Bb)

q^2 => frequency of the homozygous recessive individuals

(bb)

Practice problem:

$p + q = 1$

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

Q:- Sickle cell anaemia is caused by a mutation in a gene called HBB

It is a recessive genetic disease.

In a population, 20 out of 500 individuals are born with a severe form of sickle cell anaemia.

What percentage of the population will be heterozygous for this gene?

$q^2 = \frac{20}{500} = 0.04$

$q = 0.2$

$p = 1 - 0.2 = 0.8$

(Hh) = ??

$h = 0.2$

$H = 0.8$

Hh frequency $= 0.8 \times 0.2 \times 2$

$= 0.32$

Artificial Selection

Describe the principle of selective breeding.

=) Human choose or select

=) Parents with desirable features

=) e.g. cows giving more milk; cattle with more protein and less fat.

=) bred or crossed

=) offspring selected with desirable features.

=) repeat over many generations.

=) increased in freavency of desired alleles.

=) Some background genes may or may not be eliminated.

=) Increase in homozygosity so causes inbreeding depression.

=) Directional selection

Outline how selective breeding is used to improve maize:

=) Human select
=) Best / desirable plants crossed
=) repeated by generation to offspring
=) e.g: fast growing, high yield, cold tolerant
=) hybridisation
=) two inbred lines crossed
F1 hybrid formed.
=) give more & vigorous and uniform plant.
=) F1 have uniform phenotype.
=) hybrid have higher yield.

Problems due to inbreeding:

→ breeding between closely related organism (similar genotype)

=) inbreeding depression / lack of hybrid vigor

=) more chance that harmful recessive alleles may be expressed

=) increase in ~~homozygous~~ homozygosity

=) Less genetic variation.

Outline how wheat crops have been improved by selective breeding.

=) Human select

=) cross plants with desirable features

=) example: ~~Dis eg.~~ ~~disea~~ disease resistance, pest resistance, high temperature tolerance.

=) ~~over several~~

=) repeated over several generations

=) only using offsprings with desirable features

=) frequency of desirable ~~features~~ alleles increases.

Improving the milk yield of dairy cattle

=) Human select

=) ~~Butter~~ cows with desirable features

=) example: • high milk production
• more protein in meat than fat
• disease resistance

=) repeated over several generations, only using offsprings with desirable features

=) frequency of the desirable allele increased.

=) Using artificial insemination

Evolution :

A process leading to the formation of new species from pre-existing species over time, as a result of changes to gene pools from generation to generation. due to natural selection and variation

---

How members of species is similar?

- => morphologically
- => physiologically
- => genetically
- => biochemically
- => can interbreed to form fertile offspring
- => reproductively isolated from other species.

=) share common ancestor.

=) behaviourally.

How DNA sequence data can show evolutionary relationships between species

=) DNA sequences

=) mitochondrial DNA

=) amino acid sequences

=) genetic fingerprinting

=) Compare sequences from both species.

=) Calculate % of bases / amino acids

more similar

(DNA/amino acids) Sequences

more closely related

the species

share common ancestor.

change.

mt genome

⇒ Properties of mt DNA making it suitable to study evolution:

⇒ mutations occur at constant rate.

⇒ not protected by histone protein

⇒ no enzymes to repair DNA mutation

⇒ many copies of mtDNA per cell.

How Speciation ~~may~~ occur as a result of genetic isolation by geographical seperation?

=) Species split into two populations

=) Seperated by geographical barrier, such as mountain range, forest or stretch of water.

=) Different selection pressures on the two populations.

=) Different mutations.

⇒ no breeding or allele flow or gene flow between the populations.
⇒ for long time and over many generations

⇒ individual with beneficial alleles are selected and survive and reproduce, thus have selective advantage.

⇒ Genetic drift or founder effect causes change in allele frequency (✗) leads to different morphological or behavioural features

⇒ After many generations,

⇒ they can no longer interbreed successfully with their orgird populations.

⇒ Allopatric speciation.

How speciation occurs as a result of genetic isolation by ecological and behavioural seperation (sympatric speciation)

=) Behavioral or ecological isolation
=) no geographical barrier.
=) reproductive isolation
=) no gene flow with parent population.
=) So hybrid gene pool maintained.
=) different mutations occur in hybrid population to parent populations.

=) natural selection occurs.

=) pre-zygotic isolating mechanism

=) Sympatric speciation.

General Theory of evolution:

=> organism changes over time

=) within a species there is variation in phenotype

=) due to genetic variation

=) caused by mutation.

changes in gene pool from generation to generation

=) Different selection pressures.

=) individuals, ~~with~~ are better adapted have selective advantage,

=) survive and ~~the~~ reproduce to pass on new advant alleles to offspring

=) changes allele frequencies gen
2) Speciation / natural / ~~ag~~ sel