CELL DIVISION: MITOSIS (UNIT-III Part-2

MITOSIS : is also called somatic cell division / equational division.

- Chromosome number is kept constant in daughter cells
- Two daughter cells are formed from parent cell.

It consists of following phases:—

Interphase : consists of period of growth & development between cell divisions. It is further divided into 3 phases:

(i) G1 phase : First gap phase / First growth phase : involves synthesis of proteins & RNA.
-chromatin is fully extended during this phase.

(ii) S-phase : synthetic phase : Replication of DNA and synthesis of histone occurs.

(iii) G2 phase : Second gap / growth phase : synthesis of RNA and protein continues which is required for cell growth.

M-phase : Mitotic phase further consists of
(i) Karyokinesis (Nuclear division)
(ii) cytokinesis (Division of cytoplasm)

(i) KARYOKINESIS : is further divided into four phases:

(a) Prophase : - Nuclear membrane disintegrates
- Nucleolus disappears
- Chromatin fibers condense to form chromosomes
- Spindle apparatus forms.

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(b) Metaphase : Chromosomes arrange themselves at equator of the spindle apparatus.

(c) Anaphase: Each centromere splits so that two sister chromatid so have their own centromere.

- Sister chromatids move towards opposite poles & may be V-shaped or J-shaped.

(d) Telophase: Sister chromatids reach opposite poles

- At each pole, chromosomes get surrounded by new nuclear membrane
- Nucleolus is reformed
- Chromosomes decondense to form chromatin.

MEIOSIS: is a special ... homosomes duplicate only ... So, one parental cell ... having half the chr... So Meiosis is ... of two divis...

MEIOSIS - ... involves ... chro...

SIGNIFICANCE OF MITOSIS

5.1 Significance of Mitosis

The mitosis has the following singificance for living organisms:

1. The mitosis helps the cell in maintaining proper size.
2. It helps in the maintenance of an equilibrium in the amount of DNA and RNA in the cell.
3. The mitosis provides the opportunity for the growth and development to organs and the body of the organisms.
4. The old decaying and dead cells of body are replaced by the help of mitosis.
5. In certain organisms, the mitosis is involved in asexual reproduction.
6. The gonads and the sex cells depend on the mitosis for the increase in their number.

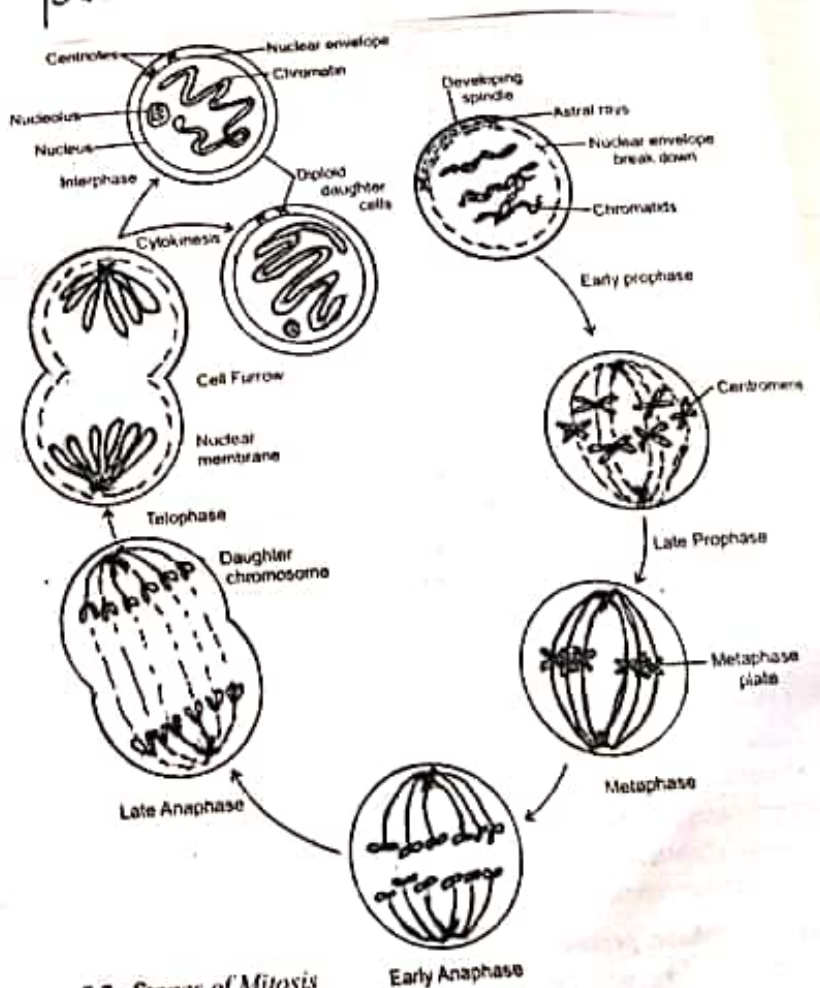

Figure 5.2: *Stages of Mitosis*

MITOSIS (DIAGRAMS)

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MEIOSIS

MEIOSIS: is a special type of division in which chromosomes duplicate only once, but cell divides twice. So, one parental cell produces 4 daughter cells, each having half the chromosome number & DNA amount. So Meiosis is called Reductional division. It comprises of two divisions: Meiosis I & Meiosis II

MEIOSIS-I: also called reductional division because it involves formation of 2 daughter cells which have chromosome number half to those in parental cell. It is divided into two parts:

(I) Karyokinesis-I

involves division of nucleus and is further divided into four phases:

A. **PROPHASE-I**: is of longest duration and again divisible into 5 subphases:

(a) **Leptotene**: thin-thread stage i.e. chromosomes appear thin, uncoiled and elongated & formation of aster occurs.

(b) **Zygotene**: Pairing of homologous chromosomes i.e. Synapsis occur to form **bivalents** (one paternal & one maternal chromosome).

- Synapsis occur with the help of synaptonemal complex (formed of nucleoprotein).

(c) **Pachytene**: Crossing over occurs i.e. 2 non-sister chromatids exchange their parts. The points where crossing over occurs are called chiasmata.

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(d) Diplotene : ~~Ex~~ - Synaptonemal complex dissolves
- Desynapsis of homologous chromosomes begin.
- Terminalisation occurs i.e chiasmata start moving towards the end of chromosomes.

(e) Diakinesis : Terminalisation is completed
- Nuclear membrane & nucleolus disappear.
- formation of spindle occurs.

B. METAPHASE-1 :
- Bivalents arrange themselves in two parallel equatorial/ metaphase plates.
- Centromeres of homologous chromosomes lie equidistant from equator.

C. ANAPHASE-1 : Homologous chromosome start moving towards opposite poles. Disjunction of chromosomes occur.

D. TELOPHASE-1 :
- Nuclear membrane & Nucleolus forms at each pole.
- Spindle fibres disappear

(2) Cytokinesis - 1
- may / may not occur.
- occurs by cell furrow formation in animal cells.
- cell plate formation in plant cells.

MEIOSIS-II
chromosomes
forms divided
D KARYOKINE
of each
- divided
(a) PR

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MEIOSIS-II - also called equational division ∵ no. of chromosomes remain same after meiosis-I further divided into 2 parts

D KARYOKINESIS-II: involves separation of 2 chromatids X's of each chromosome & their movement to separate cells.

- divided into 4 phases:

(a) PROPHASE-II :- Nuclear membrane disintegrates, nucleolus disappears
- Chromatin fibres condense to form chromosomes.
- formation of asters.

(b) METAPHASE-II : - Arrangement of chromosome at the equator of spindle apparatus
- Centromeres lie at the equator while arms are directed towards poles.

(c) ANAPHASE-II : Splitting of centromere of each chromosome and movement of chromatids towards opposite poles.

(d) TELOPHASE-II : formation of daughter nucleus at each pole, nucleolus appears in each nucleus.
- Spindle fibres disappear.

SIGNIFICANCE of MEIOSIS:

1. produces haploid gametes for reproduction.
2. maintains constant chromosome number generation after generation.
3. Crossing over is a source of variations.
4. Non-disjunction is also a source of variation.

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MEIOSIS-I

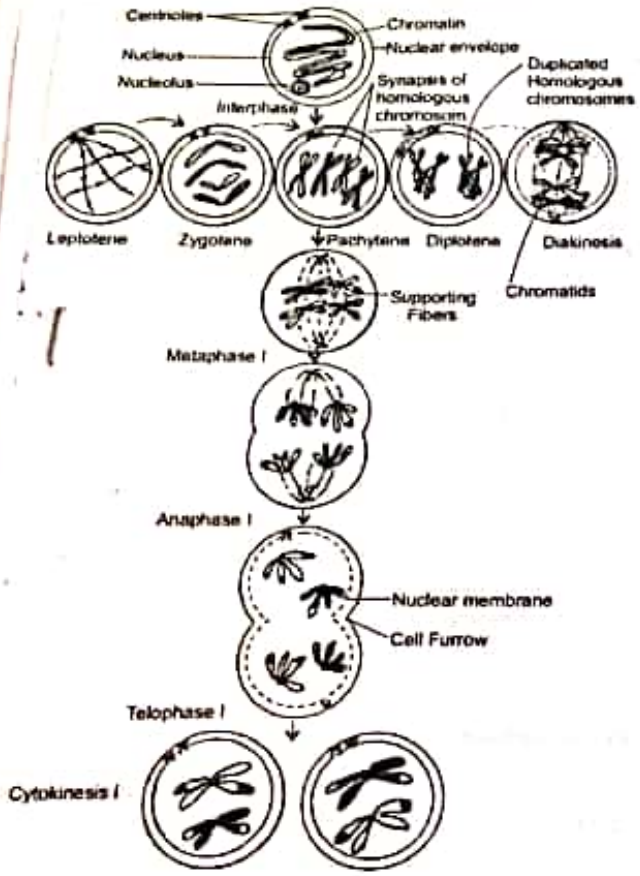
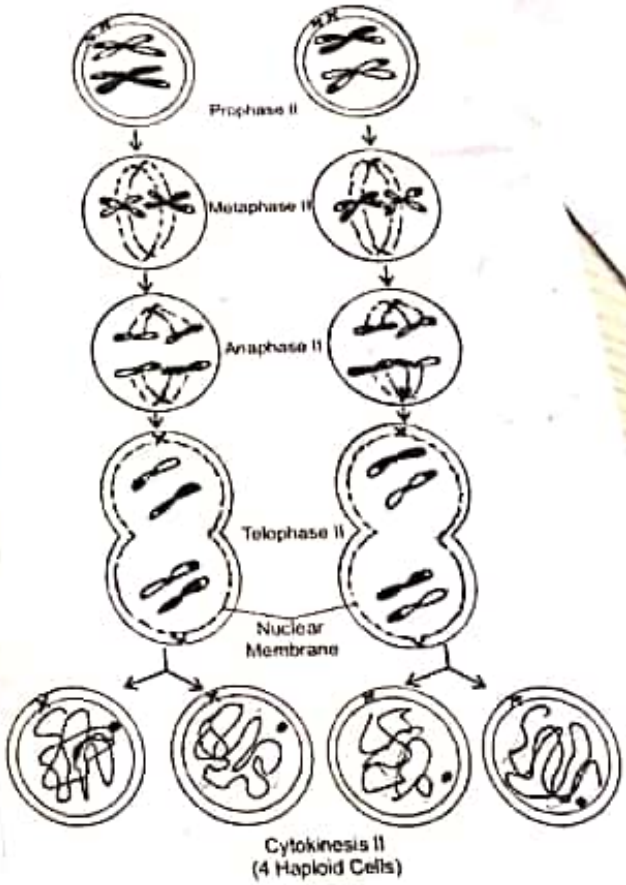


Figure 5.3: *Meosis I*

MEIOSIS-II



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5.4 DIFFERENCE BETWEEN MITOSIS AND MEIOSIS

S.No.	Mitosis	Meiosis
1.	Mitosis takes place within somatic cells (cells that make up the body).	Meiosis takes place within gamete cells (sex cells).
2.	One single division of the mother cell results in two daughter cells.	Two divisions of the mother cell result in four meiotic products or haploid gametes.
3.	A mitotic mother cell can either be haploid or diploid.	A meiotic mother cell is always diploid.
4.	The number of chromosomes per nucleus remains the same after division.	The meiotic products contain a haploid (n) number of chromosomes in contrast to the (2n) number of chromosomes in mother cell.
5.	It is preceded by a S-phase in which the amount of DNA is duplicated.	In meiosis, only meiosis I is preceded by a S-phase.
6.	The prophase is of short duration and includes no substage.	The prophase is of longer duration and it completes in six successive stages, viz., proleptotene, leptotene, zygotene, pachytene, diplotene and dikinesis.
7.	In prophase no pairing or synapsis takes place between the homologous chromosomes.	In prophase pairing or synapsis occurs between the homologous chromosomes.
8.	Duplication of chromosomes takes place in the early prophase.	Duplication or splitting of chromosomes takes place in the late prophase (pachytene stage).
9.	In mitosis, there is no pairing of homologous chromosomes.	During prophase I, complete pairing of all homologous chromosomes takes place.
10.	There is no exchange of DNA (crossing-over) between chromosomes.	There is at least one crossing-over or DNA exchange per homologous pair of chromosomes.

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11.	The centromeres split during anaphase.	The centromeres do separate during anaphase II, but not during anaphase I.
12.	In Metaphase the chromatids occur in the form of dyads.	In Metaphase the chromatids of two homologous chromosomes occur as the tetrads.
13.	The chromosomes are long and thin in Anaphase	The chromosomes are short and thick in Anaphase
14.	The telophase always occurs	The first telophase is sometimes omitted
15.	The whole process completes in one sequence or phase.	The whole process completes in two successive divisions which occur one after the other
16.	The genotype of the daughter cells is identical to that of the mother cells.	Meiotic products differ in their genotype from the mother cell.
17.	After mitosis, each daughter cell has exactly same DNA strands.	After meiosis, each daughter cell has only half of the DNA strands

QUESTIONS

1. What is the cell division? How many types of cell division occur in living organisms?
2. Discuss the use and biological significance of each type of cell division.
3. Define the terms: cell cycle and mitosis. Name the stages of cell cycle. Which is usually the longest stage?
4. Describe process of mitosis in detail. What are their biological significances?
5. What basic activities occur during mitosis? How does mitosis differ in animal and plant cells?
6. What is meiosis? Describe the major features of each meiotic phase.

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UNIT-III

Morphology of virus : A virion is composed of nucleic acid surrounded by protein coat that protects it from the environment & is a vehicle of transmission from one host cell to another. Virus consist of following parts :

① Nucleic acid : A virus can have DNA or RNA as genetic material but never both. The nucleic acid of virus can be double-stranded / single stranded. Depending on the virus the nucleic acid can be linear or circular.

② Capsid : The nucleic acid of a virus is surrounded by a protein coat called the capsid. Each capsid is composed of individual subunits called capsomeres.

③ Envelope : In some viruses, the capsid is covered by an envelope, which is a combination of lipids, proteins & carbohydrates. This envelope is derived from plasma membrane of the host.

④ Spikes : Depending on the virus, envelope may / may not be covered by spikes. Spikes are carbohydrate, protein complexes that project from the surface of the envelope

- Viruses are classified into different morphological forms on the basis of their capsid architecture :-

(i) Helical viruses — resemble long rods that may be rigid or flexible. Eg rabies virus

(ii) Polyhedral viruses : Many-sided virus, mostly ~~icosa~~ icosahedron. eg. poliovirus

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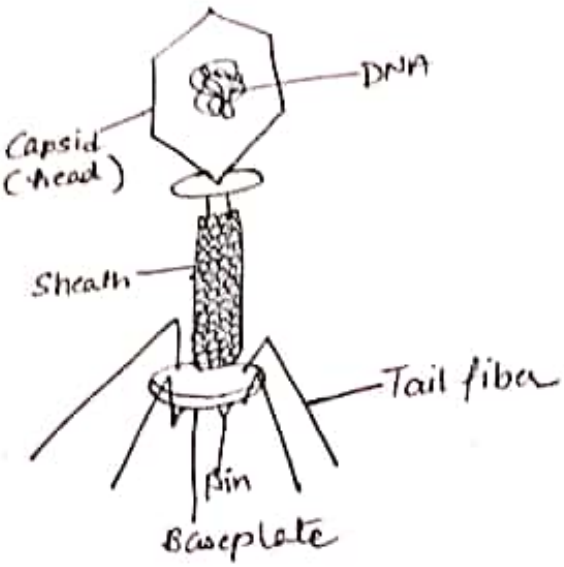
(iii) Enveloped virus : mostly roughly spherical
(iv) Complex viruses : have complicated structures

St diagrams → for Morphology of virus

Size of Viruses
- 20–1000nm in length
- Most are smaller than bacteria



Morphology of Fungus :

- Molds (Multicellular fungus)
- Yeast (Unicellular fungus)

① Molds :- The thallus (body) of a mold consists of long filaments of cells, called hyphae. Hyphae are of two types :

(a) Septate hyphae

The hyphae contains crosswalls called septa, that divide them into uninucleate cell-like units

(b) coenocytic (non-septate) hyphae

The hyphae do not have septa & appear as long cells with many nuclei nucleus.

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Under favorable conditions, the hyphae grow to form a filamentous mass called mycelium.

Vegetative hypha: the portion of hypha that obtains nutrients

Reproductive hypha: the portion concerned with reproduction.

② Yeast: yeast are non-filamentous unicellular fungi that are typically spherical/oval.

Pseudohypha: Some yeast produce buds (for reproduction) that fail to detach themselves; these buds form a short chain of cells called pseudohyphae.

size: yeast cells are larger than most bacteria, ~~ranging~~ They range is size from 5-30 µm (length) & 1-5 µm (width).

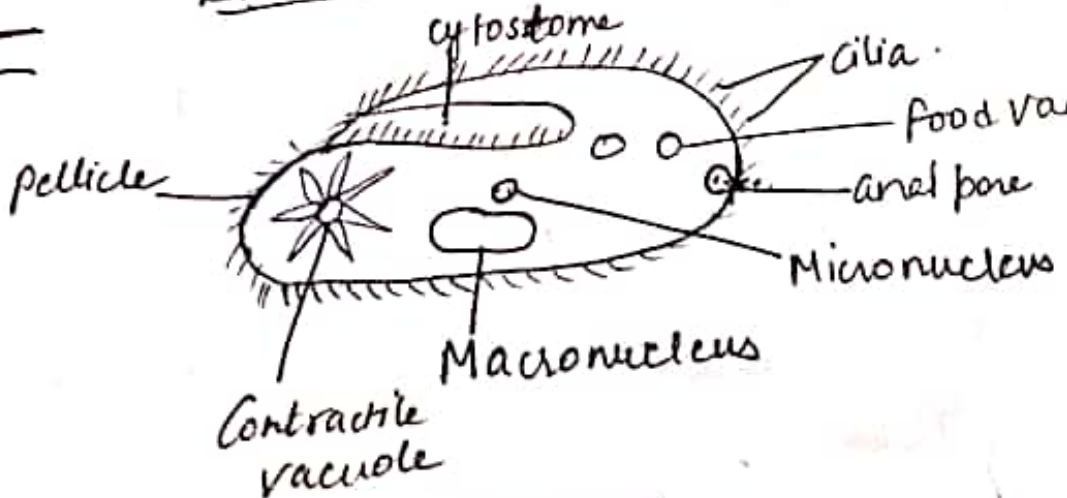
Morphology of Protozoa :-

Size & shape of protozoan organisms vary considerably.

for eg: Amoeba proteus (600 µm or more)

Leishmania donovani (1-4 µm)

DIAGRAM



PARAMECIUM

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Cytoplasm: In majority of protozoa, cytoplasm is differentiated into ectoplasm & endoplasm

Nucleus: The protozoan cell has at least one eukaryotic nucleus. Many have multiple nuclei. In ciliates (eg. paramecium), two types of nuclei are present - macronucleus & micronucleus.
↓ controls metabolic activities & regeneration processes
↓ concerned with reproduction

Cell coverings: Although all protozoa possess a cell membrane, many have combinations of membranes called pellicle.

Feeding structures: (i) Cytostome: Ciliates take in food by waving their cilia toward a mouth like opening called a cytostome.
(ii) Amoebas engulf food by surrounding it with pseudopods & phagocytizing it

Cysts: Most protozoa form resistant cysts under unfavourable conditions.

Other protective structures: to defend themselves
eg- mucocysts, trichocysts

Locomotor organelles: (a) pseudopodia: temporary projection of a part of cytoplasm as in Amoeba.
(b) Flagella: eg in Trypanosoma,
(c) cilia: locomotor function, tactile organelle, aid in ingestion of food.

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Beneficial & Harmful Effects of Microorganisms :

BENEFICIAL EFFECTS OF BACTERIA

cteria are beneficial for the human body in the following ways:

1. Friendly bacteria are a great help in the processing of human body wastes.
2. They produce byproducts of acetic and lactic acids. These byproducts of acetic acid and lactic acid help in fighting the harmful bacteria like *Shigella*, *Salmonella* and *E. coli*.
3. *Help in vitamin formation:* At least 7 important B Vitamins are produced with the help of friendly bacteria.
4. *Help in Improving the Immune System:* They speed up the creation of antibodies.
5. *Help in the Creation of Lactase:* Lactase is an enzyme that helps in digestion of milk and milk products by the human body.
6. Lack of friendly bacteria in the body can result in unregulated and unbalanced hormonal levels. Unbalanced hormones can lead to hair loss, prostrate trouble, breast enlargement and irregular fat distribution in men.
7. Friendly bacteria help in reducing the deposits of cholesterol in our bloodstreams and helps in the excretion of cholesterol through our bowels.
8. *Kill Cancer-Causing Compounds:* Various cancer-causing compounds enter our body through ingested food and as byproducts of many other organisms, the friendly bacteria kill these.
9. Help in the management of high stress levels and reducing food cravings in the body
10. Help in the treatment of various diseases and infection.
12. *Decomposition:* They help in the dajradation of complex organic internal into simpler compounds.
13. *Nitrogen fixation:* Nitrogen fixation is a process found only in some bacteria which removes N_2 from the atmosphere and converts it to ammonia (NH_3), for use by plants and animals.

HARMFUL EFFECTS OF BACTERIA

8.3.4 Harmful effects of bacteria

1. Certain bacteria act as pathogens and cause tetanus, typhoid fever, food-borne illness and tuberculosis.
2. Bacteria that usually live harmlessly in the body may cause infections when a person's resistance to disease is reduced in conditions such as AIDS (Acquired Immune Deficiency Syndrome).
3. Not all stomach bacteria are beneficial, some of the stomach bacteria enter the body through the mouth, and they can survive in the acidic conditions in the stomach and can cause serious diseases and can be fatal.
4. *Campylobacter* is a group of bacteria that can create illnesses in humans and is a common cause of food poisoning.
5. Harmful bacteria in food cause botulism, which can cause paralysis or even death if even one millionth of the bacterium is ingested.
6. Bacteria-carrying fleas found on animals such as rats and mice transmit the bacteria that are believed to have caused the deaths of millions of people in human history.

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BENEFICIAL AND HARMFUL EFFECTS OF PROTOZOA

4.3 Beneficial effects of Protozoa

1. Protozoa are primary consumers in aquating food chain i.e. they serves as an important link in the aquatic food chain.
2. Protozoa (like bacteria feeding protozoa and saprophytic protozoa) are helpful in maintaining the ecological balance of many communities in the wetlands and in the aquatic environment.
3. Many protozoa are useful in the treatment of industrial wastes.
4. They are used as fertilizers after the treatment processes.
5. Their capacity to reproduce a sexually make them an important organism in the cloning processes and other research.
6. They help in indicating the oil-bearing deposits.
7. Protozoa are helpful in the aerobic and anaerobic biological sewage treatment.
8. It also improves the water quality and texture.

.4 Harmful effects of Protozoa

1. Protozoa (like *Balantidium Coli, Giardia intestinalis*) are involving in causing different types of dysentery in humans.
2. Protozoa like Sporzoa responsible for causing the malaria. It also infect the liver and red blood cells.
3. They decreases the production of nitrates and reduces soil fertility because protozoa feed on nitrogen fixing bacteria.
4. Many species of protozoa act as parasite and causes various diseses inside the human body like sleeping sickness, Kala Azar is tropical disease caused, Skin disease.

BENEFICIAL AND HARMFUL EFFECTS OF FUNGI

3 Beneficial Effects of Fungi

Fungi have been used in biotechnology for many years. Some benefits of fungi are described below

1. *Bread & Brewing:* The products of yeast fermentation (CO_2 & alcohol) are exploited in bread making & alcohol brewing.
2. *Decomposers:* Fungi are the main agents of decay of plant wastes in the environment, decomposing substrates to CO_2, H_2O and fungal biomass and releasing other nutrients back to the biosphere.
3. *Symbiosis:* Fungi can enter into specialized & intimate, mutually beneficial associations with higher plants, other microbes and animals.
4. *Philological Control:* Fungi can be used to control insect pests, weed plants & plant diseases by exploiting their natural antagonistic, competitive & pathological attributes.
5. *Bioremediation:* The degradative abilities of fungi can be exploited to decompose man-made pollutants such as hydrocarbons, pesticides & explosives.
6. *Industrially important fungi:* Fungi naturally produce antibiotics, immune Suppressants, acids, enzymes & several other classes of useful natural products.

8.4.4 Harmful Effects of Fungi

1. *Biodeterioration:* Degradative activities of fungi in losses. Materials containing large quantities of cellulose, leather & hydrocarbons can be used as substrates of fungi, providing that there is an adequate water supply.
2. *Plant disease:* Fungi are capable of causing significant losses to crops both before & after harvest.
3. *Animal & Human Disease:* Fungi can cause both superficial & deep, life threatening infections of both man & animals.
4. *Fungal Toxicosis:* Ingestion of fungi or their secondary metabolic products, accidently or deliberately, can cause intoxication & occasionally death of both humans & animals.

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Role of Immune system in Health & disease :

Immunity is the natural ability of the animals & plants to resist infection by parasitic organisms & fight against diseases caused by them.

The role of immune system is to protect our body from any foreign matters that might cause any damage or homeostasis imbalance. The success of immune system depends on its ability to discriminate between self & non-self cells.

There are two kinds of defence mechanisms against pathogens : non-specific & specific

① **Non-specific defence mechanisms :** resist infection by blocking the entry of pathogens into the body or destroying them through means other than antibodies. It comprises of following components :

ⓐ **Physical & chemical barriers :**

- skin is the first line of defence and acts as a physical barrier against the entry of pathogens.
- sweat & sebum makes the skin acidic which discourage the growth of microorganism on the skin.
- sweat also contains lysozyme that destroys the cell walls of many bacteria.
- lysozyme is also present in tears & saliva which checks the infection & food spoilage respectively.
- Highly acidic medium in gastric juice kills pathogenic bacteria in the stomach.
- Respiratory tract has five hair which filter out the foreign particles.

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- The mucus of nostril trap the microorganisms ca... along with air.

(b) Inflammatory response: provides second line of defence with the help of several chemicals.
- The injured area becomes red, swollen due to increased supply of blood. This occurs due to secretion of histamine from mast cells that cause local vasodilation.

(c) Phagocytosis: Neutrophils & macrophages are the phagocytic cells that are involved in phagocytosis i.e a process in which phagocytic cells engulf bacteria, dead tissue cells etc. and digest it. It is one of the main mechanism of innate immunity.

(d) Complement system: is a defensive system of over 30 proteins produced by liver & circulating in blood that enhances the ability of Antibodies & phagocytic cell to clear microbes & damaged cells, promotes inflammation etc.

(e) Interferon: are a class of antiviral proteins produced by animal cells after infection with virus & prevents viral multiplication in neighbouring cells.

(2) Specific defense mechanism: forms the third line of body's defence. Lymphocytes provide specific defence mechanism (B-cells & T-cells). It is of two types:

(a) Humoral / Antibody-mediated immunity: involves production of antibodies that act against foreign organisms & substances. Cells called B cells (B lymphocytes) are responsible for the production of antibodies. Antibodies are found in blood plasma, lymph & mucus secretion.

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Cell-mediated immunity : involves T-cells (or T-lymphocytes)
The T cells are of 3-types :-

(1) Killer T cells : cause direct destruction of antigen by release of lysosomal proteins.

(2) Helper T-cells : Stimulate the production of Antibodies by B. lymphocytes.

(3) suppresser T-cells : Suppresses the immune system keeping it away from attacking the own body cells.

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VARIATION AND SPECIATION

Variation : The diffeunces produced by individual of a species or their offspring.

IGIN AND EVOLUTION

Classification of variations. Variations are of two types depending upon the nature of cells like somaticell and germ cell. The variation due to somatic cell is somatogenic and germ cell is blastogenic. The two types of variation are :

A. Somatogenic. The important characteristics of somatogenic variations are:

(*a*) It effects the somatic cell of organism which dies with the end of life.

(*b*) It is not transmitted to next generation.

(*c*) It is acquired type variation which is gaind by organism during its own life and end with its death.

Causes. It is produced by three types of factors such as

1. Environment 2. Use and disuse of organs and 3. Conscious efforts.

1. Environment. It includes all the factors that affect the organisms like habit at light, temperature, nutrition and environment give more variation in plants in comparison to animals because plants are unable to move. The ability of an organism to change its phenotype in response to environmental conditions is termed as phenotype plasticity. The four factors like light, temperature, habitat and nutrition play important role in the production of variations.

For example, Plants grow in less light (shade) become weak, pale in colour, long internodes, broad leaves while in full light plants produce strong tissue, small and thick leaves.

Deficiency of iron causes chlorosis (lack of green pigment chlorophyll which synthesize food in presence of light in plants).

Plants growing in hot and dry conditions show reduced gorwth of shoot system (stem) and increased growth of root system.

2. Use and disuse of organs. A regular use of an organ makes it better, stronger while unproper use of organ reduces the growth making it weaker. *For example*, An animal living in zoo is weaker than that living in jungle.

3. Conscious efforts. Somatic variations can occur in humans, in domestic animals and plants by conscious efforts of man *e.g.*, small feet acquired by wearing tight shoes in chinese, receiving education, learning an art are examples of somatic variations produced by man's conscious efforts.

Triming which gives desired shape to plants is an example of somatic variation produced by conscious efforts of human.

B. Blastogenic or germinal variations. Important characteristics of germinal variations are :

(*a*) They affect the germ cells of an organism.

(*b*) It is inheritable.

(*c*) It is transmitted from generation to generation because germ cells carry the hereditary characters.

Germinal variations are of continuous and discontinuous type.

Continuous variations. These are small, indistinct differences from the average condition.

They give the quantitive characteristics such as height in man. These are unstable and do not contribute to the formation of new species.

These give fluctuating variations by increase or decrease in the normal type.

The continuous variation is produced by new combination of characters (chromosome) at the time of gamete formation into daughter cell in the anaphase

enter hair follicles and sweat ducts.

7. Some microorganisms can gain access to tissues by inoculation through the skin and mucous membranes in bites,

being phagocytized

Components of

1. Proteins in the c

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I, at the time of fertilization to form zygote and crossing over (recombin
exchange of genetic material takes place in meiosis I.

Continuous variations are two types : Substantive continuous variations w
affect the weight, shape, size and colour of an organism or its parts like nun
height, milk production in dairy cattle.

Meristic continuous variations which involve by change in the number of ce
tain parts of an organism. *For example*, presence of extra pinna in man.

Continuous variations improve the ability for existence and offspring of plant/
animal by interbreeding/hybridization.

Discontinuous variations. These are stable and inheritable. They is give large differences in offspring from the parents.

These are not common in nature.

They appear suddenly in the form of mutation or the mutants.

Discontinuous variations are produced by modification in the structure of chromosome, alteration in the chemical nature of gene, change in the number of chromosome, by exposure to mutagens like radiations and chemicals such as HNO_2.

Discontinuous variations are of two types : Substantive discontinuous variations which affect the size, weight, shape and colour of an organism or its part. *For example*, hairless varieties of dogs, mouse, cats are produces suddenly in a single generation.

Meristic discontinuous variations involve bv a change in number of certain parts of an organism like presence of extra fing r in human beings.

Importance of Variations.

1. Variations give adaptations that mean to change the ability of an organism to adjust according to environmental conditions.
2. They act as reactants for evolution. There will be no evolution without old species, the latter produce new species with variations.
3. They provide better methods of survival by giving better conditions.
4. Variations give similarity to its own individuals.
5. Variations improve the quality and quantity of useful plants.
6. They improve the races of animals.
7. Discontinuous variations produce new genes in organism in a single generation.
8. Without variations, no hereditary characters will be available for study time.
9. Variations give modifications at the time of need which are beneficial for living organism.
10. Variations play important role in evolution.

4.15 SPECIATION

The basic unit of classification in both plants and animal is species. So speciation means orgin of new species. The definition of speciation in very difficult which can be applied uniformly throughout the animal and plant kingdoms. Species can be defind as a population of individuals with similar functional characteristics, different from other groups of individuals, which have a common ancestry (gene-pool) and produce fertile offspring under natural conditions through interbreeding. Gene pool is the result of all the genes present in all the individuals of a species.

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A species has a number of populations. They live in different geographical areas with different environmental conditions. Natural selection and mutation is very helpful to adjust the species according to new environmental conditions.

Interbreeding under nutural conditions to produce offsprings is present in same species. The new species is formed only either due to migration of some member of the population in new area or rapid change in the environment of that population. Some members of population will either die out or adjust itself according to new environmental conditions. These changing condition results in more and more dissimilar population which accumulates in the members of population and finally results in to a new species or organism which do not interbreed and become different species.

Type of speciation :

(*i*) **Allopatric speciation.** The species inhabiting different geographical areas. Geographical isolation of two or more groups from original population results into different species is known as allopatric species.

(*ii*) **Sympatric speciation.** The species inhabiting same geographical areas within original population. Sympatric species are reproductively isolated either by *ecological or **ethological isolation. Sympatric species exist in same area but have different ecological niches.

(*iii*) **Monotypic speciation.** It consist of single sub-species.

(*iv*) **Polytypic speciation.** The species which consist of two or more sub species are called as polytypic species.

(*v*) **Morpho-speciation.** These species are characterized by morphological resemblance only.

(*vi*) **Genetical species.** These are the groups of interbreeding populations which are reproductively isolated from one another.

(*vii*) **Biological speciation.** These are the groups of actually or potentially interbreeding natural population which are reproductively isolated from one another.

(*viii*) **Sibling speciation.** A pair or groups of very similar and closely related species which can not interbreed are called as sibling species.

(*ix*) **Evolutionary speciation.** These are lineages evolving on altogether different lines from one another. Lineages represent the ancestral descendant sequences of populations.

ROLE OF HYBRIDIZATION AND POLYPLOIDY IN SPECIATION

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defenses of the host.
pathogenicity.

s
1)

n a particular pathogen gains
its portal of entry.

–438)

penetrate mucous membranes of
piratory, gastrointestinal, and

naled with droplets of moisture
s to the respiratory tract.
nost common portal of entry.
cess via the genitourinary tract
mucous membranes.
strointestinal tract via food,
gers.
: penetrate intact skin; they
ducts.
in access to tissues by inocula-
ıcous membranes in bites,
. This route of penetration is

gain access through their specific portal of entry.

Numbers of Invading Microbes (p. 438)

1. Virulence can be expressed as LD_{50} (lethal dose for 50% of the inoculated hosts) or ID_{50} (infectious dose for 50% of the inoculated hosts).

Adherence (pp. 438–441)

1. Surface projections on a pathogen called adhesins (ligands) adhere to complementary receptors on the host cells.
2. Adhesins can be glycoproteins or lipoproteins and are frequently associated with fimbriae.
3. Mannose is the most common receptor.
4. Biofilms provide attachment and resistance to antimicrobial agents.

BACTERIA: Pathogens

How Bacterial Pathogens Penetrate Host Defenses (pp. 441–443)

Capsules (p. 441)

1. Some pathogens have capsules that prevent them from being phagocytized.

Components of the Cell Wall (p. 442)

1. Proteins in the cell wall can facilitate adherence or prevent a pathogen from being phagocytized.
2. Some microbes can reproduce inside phagocytes.

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Enzymes (p. 447)

1. Leukocidins destroy neutrophils and macrophages.
2. Local infections can be protected in a fibrin clot caused by the bacterial enzyme coagulase.
3. Bacteria can spread from a focal infection by means of kinases (which destroy blood clots), hyaluronidase (which destroys a mucopolysaccharide that holds cells together), and collagenase (which hydrolyzes connective tissue collagen).
4. IgA proteases destroy IgA antibodies.

Antigenic Variation (p. 447)

1. Some microbes vary expression of antigens, thus avoiding the host's antibodies.

Penetration into the Host Cell Cytoskeleton (p. 447)

1. *Salmonella* bacteria produce invasins, proteins that cause the actin of the host cell's cytoskeleton to form a basket to carry the bacteria into the cell.

How Bacterial Pathogens Damage Host Cells (pp. 443–449)

Using the Host's Nutrients (pp. 443–444)

1. Bacteria get iron from the host using siderophores.

Direct Damage (p. 444)

1. Host cells can be destroyed when pathogens metabolize and multiply inside the host cells.

The Production of Toxins (pp. 444–448)

1. Poisonous substances produced by microorganisms are called toxins; toxemia refers to the presence of toxins in the blood. The ability to produce toxins is called toxigenicity.
2. Exotoxins are produced by bacteria and released into the surrounding medium. Exotoxins, not the bacteria, produce the disease symptoms.
3. Antibodies produced against exotoxins are called antitoxins.
4. Exotoxins occur as A-B toxins, membrane-disrupting toxins, and superantigens.
5. Cytotoxins include diphtheria toxin (which inhibits protein synthesis) and erythrogenic toxins (which damage capillaries).
6. Neurotoxins include botulinum toxin (which prevents nerve transmission) and tetanus toxin (which prevents inhibitory nerve transmission).
7. *Vibrio cholerae* toxin and staphylococcal enterotoxin are enterotoxins, which induce fluid and electrolyte loss from host cells.
8. Endotoxins are lipopolysaccharides (LPS), the lipid A component of the cell wall of gram-negative bacteria.
9. Bacterial cell death, antibiotics, and antibodies may cause the release of endotoxins.
10. Endotoxins cause fever (by inducing the release of interleukin-1) and shock (because of a TNF-induced decrease in blood pressure).
11. Endotoxins allow bacteria to cross the blood–brain barrier.
12. The Limulus amoebocyte lysate (LAL) assay is used to detect endotoxins in drugs and on medical devices.

Plasmids, Lysogeny, and Pathogenicity (pp. 448–449)

1. Plasmids may carry genes for antibiotic resistance, toxins, capsules, and fimbriae.
2. Lysogenic conversion can result in bacteria with virulence factors, such as toxins or capsules.

II Pathogenic Properties of Viruses (pp. 450–451)

1. Viruses avoid the host's immune response by growing inside cells.
2. Viruses gain access to host cells because they have attachment sites for receptors on the host cell.
3. Visible signs of viral infections are called cytopathic effects (CPE).
4. Some viruses cause cytocidal effects (cell death), and others cause noncytocidal effects (damage but not death).
5. Cytopathic effects include the stopping of mitosis, lysis, the formation of inclusion bodies, cell fusion, antigenic changes, chromosomal changes, and transformation.

III Pathogenic Properties of Fungi, Protozoa, Helminths, and Algae (pp. 452–453)

1. Symptoms of fungal infections can be caused by capsules, toxins, and allergic responses.
2. Symptoms of protozoan and helminthic diseases can be caused by damage to host tissue or by the metabolic waste products of the parasite.
3. Some protozoa change their surface antigens while growing in a host so that the host's antibodies don't kill the protozoa.
4. Some algae produce neurotoxins that cause paralysis when ingested by humans.

Portals of Exit (pp. 453–454)

1. Just as pathogens have preferred portals of entry, they also have definite portals of exit.
2. Three common portals of exit are the respiratory tract via coughing or sneezing, the gastrointestinal tract via saliva or feces, and the urogenital tract via secretions from the vagina or penis.
3. Arthropods and syringes provide a portal of exit for microbes in blood.

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