Biology Grade 12

UNIT ONE

Microorganisms

1.1 . Bacteria

Types of microorganisms

Microorganism- literally means a very small (minute) organism.

-are organisms that are too small to be seen by our naked eye but can be seen with aid of microscope.

Microorganisms cab be, i. unicellular organisms that made only one cell.

ii. Multicellular organisms that have more than one cell.

Microorganisms are subject of microbiology.

Microbiology is the branch of biology that deals with microorganisms.

There are five main groups of microorganisms, each groups can be subdivided.

1. Protozoa- studied by protozoology
2. Algae - >> >> phycology.
3. Bacteria - >> >> Bacteriology
4. Fungi- >> >> Mycology.
5. Viruses- >> >> Virology.

Protozoa, Fungi and Algae

Protozoa:- are found in kingdom of protistae.

- Consists of unicellular organisms that lack cell wall and chloroplast.
- Cann't makes their own food, i.e. all are heterotrophic organisms.
- Most of them are motile(able to move).

Protozoans are subdivided into four based on their locomotary structure.

i. Amaeboids;- have locomotary structure called pseudopoda or 'false foot'. Pseudopoda is protrusion of cytoplasm, sometimes used for feeding through phagocytosis.
Eg. Entamaeba hisolytica – cause amoebic dysentery.

ii. Flagellates;- have flagella as locomotary structure that made of microtubules.
Eg. Gardia lambella- cause Gardiasis
Trypanosoma spp- cause sleeping sickness.

iii. Cilliates;- move by means of locomotary structure called Cillia which also made of microtubules. Eg. Paramecium

iv. Sporozoa;- have no locomotary structures.
Eg. Plasmodium spp.-cause malaria

Fungi :- found in kingdom mycota.

- Have cell wall that made of chitin.
- But have no chloroplast, so they cann't make their own food.
- They are heterotrophic ---some are saprotropic(saprobionts).
  --- some are parasitic.

The saprotrophic – release enzymes to digest dead matters or substrate on w/c they grow, and the products of digestion are then absorbed into fungus to help it grow and reproduce.

The parasitic – live on other living things, absorbing food w/c are digested by others.

Fungi- consist of organisms from unicellular to multicellular.

Unicellular fungi:- are like yeast, candida and Tenia pedis.

Yeast (saccharomyces)- used in bread(eg. bakery saccharomyces) and alcoholic drink (eg. brewery saccharomyces) making process.

Candida- is yeast like fungi that causes thrush in humans as opportunistic infection, called Candidiasis.

Multicellular fungi- some are visible and others are microscopic.

Microscopic multicellular fungi - eg. Bread molds.

Molds are made of *hyphae* w/c is microscopic strand slender (filamentous) cell of fungi that branches to form network mass called *mycelium*.

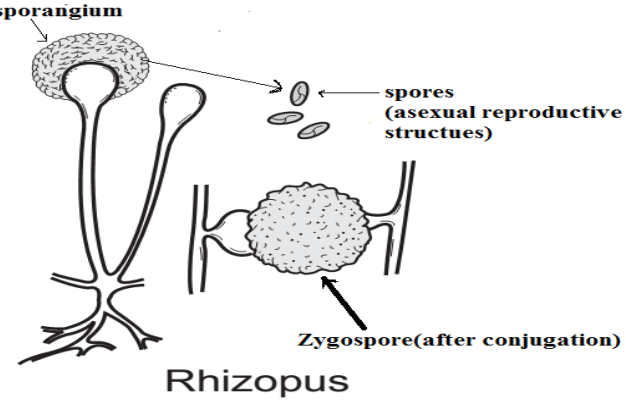
Mode of reproduction of fungi

Asexual reproduction:-

i. Budding –in yeast
ii. Sporulation-reproduction by producing asexual reproduction structure called spores.
iii. Fragmentation- breaking of hyphae into pieces.

Sexual reproduction:-

- Conjugation (homogameous sexual reproduction), eg. Molds



Rhizopus

Algae:- Found in kingdom protistae

- Consists of unicellular and multicellular eukaryotic organisms.
- They have cell-wall, that made of cellulose.
- They have chloroplast, so that they can photosynthesize food.
- They live in fresh and marine water body, so that they are phytoplankton or 'sea weeds', i.e. they are sources of food for other aquatic organisms and also sources of O_2 to aquatic environment.

They are classified into six groups

i. Dianoflagelata
ii. Euglenophyta; only algae that lack cell wall,
iii. Diatoms.
iv. Chlorophyta- green algae
iv. Rhodophyta;-red algae from w/c Agar is extracted.
v. Phaeophyta;- brown algae from w/c cosmetics are made.

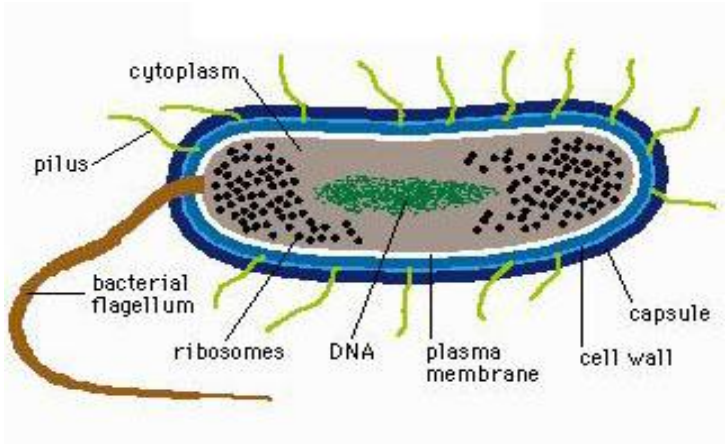
Excerpt phaeophyta, others are microscopic.

Bacteria

-Are unicellular prokaryotic organisms.
-In prokaryotic cells, there is no true nucleus and membrane bounded organelles.
Bacteria do not contain mitochondria, chloroplast, endoplasmic reticulum, etc.

Structure of Bacteria
(What are bacteria looking like?)

- Most have **capsule** or **glycocalyx**, w/c is protective slime layers.
-Some bacteria have **flagella**; w/c is simple type.
-All bacteria contain **pili (fimbrae)** around the surface of the cell, w/c use to attach on other surfaces.
-All bacteria have **cell membrane**, **cell wall** (that made of peptidoglycan), cytoplasm, ribosome(70's), and DNA (looped and naked).
-The region where DNA is found in the cytoplasm is called nucleoid.
-Some bacterial cells have small circular self-replicating DNA called **plasmids**.



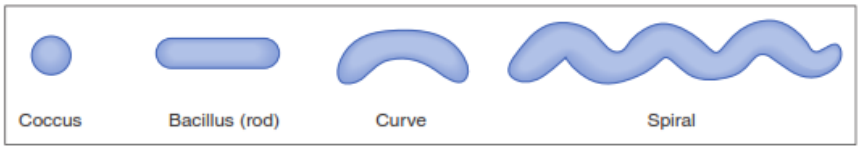
Shapes of bacteria
(Are all bacteria the same shape?)
Bacteria have different size, shape and arrangement.

Size
Bacterial cell vary greatly in their size and usually much smaller than eukaryotic cells. Their length is b/n (0.1) 1µm to 10µm.

Shape
Bacterial shapes come in three main shapes.

1. cocci(sing. Coccus):- spherical bacteria
2. Baccilli(sing. baccillus):- rod shape bacteria
3. spirochates:-spiral or corkscrew-shaped bacteria

(Vibro: rod when curved into coma shape. eg. Vibro cholerae)



Arrangement

i. Coccus
1. Single(coccus)
2. pair(diplococcus)
3. chain(streptococus)
4. cluster(staphylococcus)

ii. Bacillus
1. Single(bacillus)
2. Pair(diplobacillus)
3. Chain(streptobacillus)
4. Flagellates

iii. Spirochates
1. Spirochates
2. Borella
3. Treponema
4. Spirilla

Other way of classifying bacteria

- Based on differential stain

Differential stain- is a test that uses staining to classify organisms or organic material.

Types of differential stain

1. Gram stain
2. Acid fast stain
3. Special stain- used to stain flagella and endospores.

Gram staining;- is a test for classifying bacteria and it named after Hans Christian Gram.

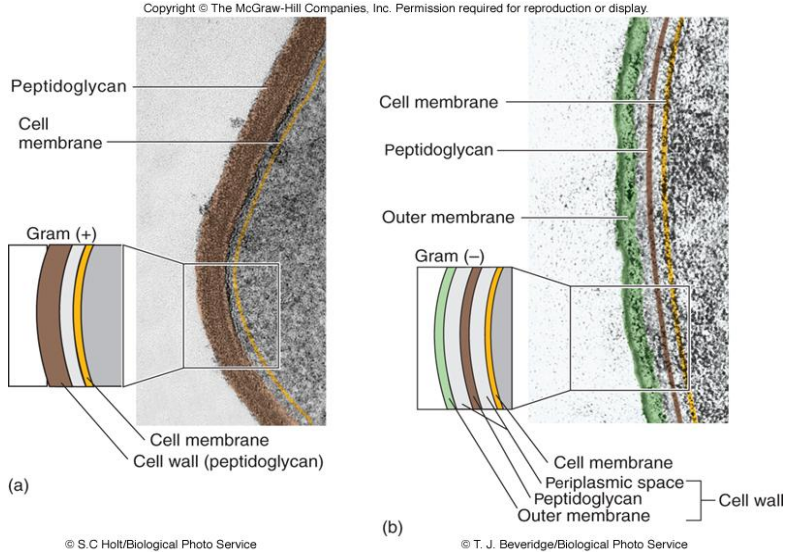
Gram staining produces different result with different types of bacteria based on thickness of cell wall.

1. Gram positive bacteria:- bacteria that stained purple and have thick cell wall.
2. Gram negative bacteria:- bacteria that stained pink and have thin cell wall.

Procedures in gram staining technique

1. Fixation
2. Simple staining by crystal violet, then all bacteria turn to purple.
3. Treating with iodine to form violet-iodine complex.
4. Decolorizing by washing off with 95% ethnol.
5. Counter stain using secondary stain called safranin.

At the end some bacteria stain as pink, called gram negative. And others stained as purple, called gram positive.



Gram-positive bacteria (a)

-have more peptidoglycan in the cell wall.
- no outer membrane surrounding the cell wall.
- not harmful except bacterium that cause tuberclusis.

Eg. Lactobacilli (makes yogurt & buttermilk), Streptococcus, Staphylococcus

Gram-negative bacteria (b)

-have much less peptidoglycan in their cell wall.
- have membrane out- side peptidoglycan cell wall.
- the outer membrane secretes endotoxin-which is resistant to many antibiotics.
- almost all cause more serious disease , and more difficult to treat.

Eg. Rhizobacteria grow in root nodules of legumes, Vibrio cholerae, Bordetella pertussis, Neisseria gonorrhoeae, Neisseria meningitidis

Mode of nutrition of Bacteria

i. Autotrophic – is two type
   1. Chemosynthetic –use energy from exergonic chemical reaction.
   2. Photosynthetic – use energy from light to make food.

Photosynthesis (photophosphorylation) takes place along the plasma membrane of bacterial cell.

ii. Heterotrophic – w/c are two types 1. saprotrophic 2. parasitic

Mode of reproduction of bacteria

1. Binary fission 2. conjugation

1.2. The ecology and importance of bacteria

The ecology of bacteria

Bacteria are adapted to live everywhere inside and outside living organisms. Bacteria live in various physical parameters based on the availability of light and O_2, as well as the pH, temperature and salinity of the environment.

On basis of O_2 availability – bacteria can be

-obligate aerobes- that require O_2 for growth

- obligate anaerobes- those which are inhibited or killed by O_2, and which grow only in its absence

- facultative anaerobes- which grow either in the presence or absence of O_2.

On basis of temperature availability – bacteria can be

- psychrophiles- that live at very cold temperatures

-mesophiles- Those which flourish at room temperature (25 degrees) or at the temperature of warm- blooded animals (37 degrees)

-thermophiles- those that live at high temperatures (greater than 45 degrees)

On basis of PH: bacteria can be

Acidophiles: prefers an acid medium eg. Lactobacillus acidophilus, present in the vagina of post-pubescent females . Helicobacter pylori, cause gastritis in human.

Alkilophiles: bacteria grow best at high alkaline pH. Eg. Vibrio cholerae, the cause of cholera

Large intestine of human contains large number of bacteria. Eg. E.coli

There are about 10 bacterial cells for every cell of human body.

Importance of bacteria

-cause disease in plants or animals. Human diseases caused by bacterial pathogens include tuberculosis, whooping cough, diphtheria, tetanus, gonorrhea, syphilis, pneumonia, cholera and typhoid fever, to name a few.

- used in many biotechnology(industrial processes). The biotechnology industry uses bacterial cells for the production of biological substances that are useful to human existence, including fuels, foods, medicines, hormones, enzymes, proteins, and nucleic acids.

-have great role in recycling of nutrient or biogeochemical cycling.

The role of bacteria and other microorganisms in infectious diseases

Some diseases are caused by invasion of body by microorganisms. Organisms that cause disease are called **pathogens**. A disease that is caused by microorganisms infecting the body is called **infectious or communicable** disease.

The bacteria that cause these diseases have special structural or biochemical properties that determine their virulence or pathogenicity. These include:

(1) ability to colonize and invade their host;
(2) ability to resist or withstand the antibacterial defenses of the host;
(3) ability to produce various toxic substances that damage the host.

-**Germ theory of disease** states that diseases can be caused by microorganisms, w/c proposed by Louis Pasteur. Robert Koch, and Joseph lister are also involved on the development of this theory.

Contribution of Louis Pasteur

-disproved the spontaneous generation theory once and for all.
-Discovered fermentation process.
-Discovered pasteurization process.
-Discovered vaccines.
-identified some microorganisms.

Contribution of Joseph lister

-Discovered disinfection processes. He showed carbolic acid (phenol), disinfectant that prevent infection in bones during surgery.

Contribution of Robert Koch

-He is called father of bacteriology.
- identified many microorganisms that cause diseases.
- provided koch's postulate.

koch's postulate

-idea that should always apply if microorganisms cause diseases.
i. the microorganisms must always be present, when the disease present. Should not be present if the disease is not present.
ii. the microorganisms can be isolated from infected animals(host), and grow in cultures.
iii. injecting such cultured microorganisms into healthy host should result in the same disease.
iv. it should be possible to isolate the microorganisms from this newly diseased host and grow it in culture.

How microorganisms cause diseases?

Different microorganisms cause diseases in different ways.

Bacteria- cause disease by

i. releasing toxin as they multiply to cause disease in the region of infection or other.
ii. Invading and physically damaging tissues.
-Bacterial diseases can be treated with antibiotics.

Viruses- causes by

-Disrupting the metabolic system of the cells, the genetic materials of the virus become incorporated with the cell and instruct the cell to produce more viruses and finally lyses thecell as they released.
- viruses cannot be treated with antibiotics b/c they are not true cells and live inside the immune cells where antibiotic cannot enter.

Fungi- Causes disease by

i. releasing enzyme that digest the substances in the tissues.
ii. physically damaging the tissue as hyphae grow.
iii. Secreting toxins.
iv. causing allergic reaction.

Protozoans

-Cause diseases in many d/t ways.

Transmission of diseases causing microorganisms

-The origin of microorganisms that infect other people is called the reservoir of infection.

-**Reservoir of infection**- is any person, animal, plant or soil or substance in which an infectious agent normally lives and reproduces.

Method of Transmission

Eg. 1. Human beings- are reservoir of many diseases, such as commen-cold, diphtheria, etc

2. Animals- eg. Chickens- reservoir of salmonella
   Mosquitoes- reservoir of malaria
3. soil- reservoir of tetanus
4. water- reservoir for amoeba, cholera, leginnarie's disease, etc
5. Food- reservoir for thypiod, etc
6. Air- reservoir of pneumonia, TB, etc
7. contaminated objects- reservoir of HIV/AIDS and trachoma

Because there are different reservoirs of disease causing organisms, there are many ways by which disease can be transmitted.

1. Droplet infections (Transmit Cough and sneezing). Eg. respiratory diseases
2. Drinking contaminated water; cholera, typoid, etc
3. Eating contaminated food; selmonella, listeriosis, etc
4. Direct contact; Athlet's foot and ring worm
5. Sexual contact; candidiasis, STDs, hepatitis B, etc
6. Blood to blood contact; AIDS and hepatitis B when drug users share needles.
7. Animal vectors; malaria, sleeping sickness

What other types of diseases are there?

- According to WHO'S definition **Health** is a state of complete ''physical, Mental, and social well-being.''
- **Disease** is the absence of perfect health, or is a condition with specific case in which parts or all of the body made to function become non-normal or work in less efficient manner.

1. **Human induced diseases**- disease that arises as result of a person's life style or working condition. Eg. Heart disease and fibrosis
2. **Degenerative diseases**- results from aging process during which the affected tissues deteriorate overtime due to simple 'wear and tear'.
   eg. Artheritis and Alziamers
3. **Genetic diseases**- are diseases that result from action of mutated gene.
   Eg. Hemophilia and sickle cell anemia
4. **Social disease**- disease that result from social activities and may lead to socially unacceptable behavior.
   Eg. Drug addition, STDs, culture shock, etc
5. Deficiency disease- results from lack of nutrients in our diet
   Eg. scurvy and kwashiorkor (caused by a lack of protein).

Other categories of diseases

1. **Multifactorial diseases**-condition that affected by the interaction of many factors. Eg. Artheriosclerosis- caused by aging, or deposition of fats on arteries and stress and depression.
2. **Functional diseases**- caused by malfunction of an organ or system without any damage or physical sign of disease in an organ.
   Eg. Heart disease, IBS (irritable bowel syndrome), ME (Myalgic Encephalopathy) or chronic fatigue syndrome.

How are bacteria used in industrial process(biotechnology)?

-food and beverage industry
-production of vinegar
-production of antibiotics
-sewage treatment

Food and beverage fermentation

Bacteria and other microorganisms have been used in manufacturing process of
-bread, alcohol, Irgo(yogurt), cheese, etc

Production of vinegar

-Vinegar is a dilute solution of ethanoic acid in water.
- It is used in two main ways -to flavor food
  -to preserve food
-Vinegar is too acidic for microorganisms to grow and multiply, keeping food in vinegar is good way of preserving, w/c is called pickling.
- Vinegar is produced by fermenting beer, wine and cider for second time.
- Acetobacter bacteria are used to oxidize alcohol in beer, wine and cider to ethanoic acid.
-Vinegar is made in special fermenter w/c is filled with wood shaving and alcohol source is sprayed from the top.
-the alcohol trickles down through the wood shaving, w/c are covered with acetobacter bacteria.
-As the alcohol flow down, the bacteria oxidize it in to ethanoic acid.
- Air is blown in at the bottom to supply oxygen that bacteria need.
- Vinegar produced at the bottom of wood shaving.

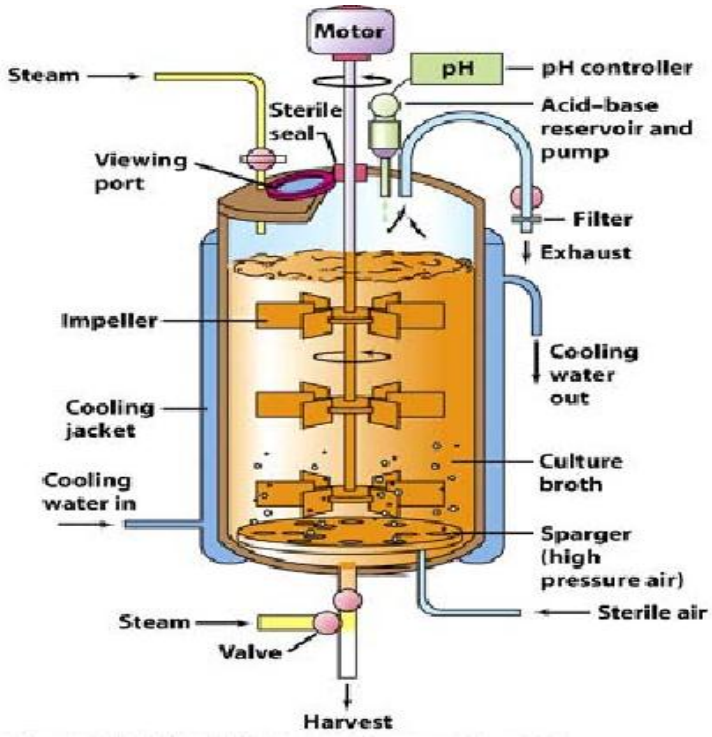
Production of antibiotics

-First antibiotics is pencillin, made from fungi called pencillium notatum

-Antibiotics can be produced using genetically modified bacteria in huge special fermentor.

- Genetically modified bacteria are also used to produce
  - –human insulin
  - human growth hormone
  - Enzymes for d/t industries
  - vaccines, for hepitis B

Fermentors: is the bioreactor or vat/ tank, vessel in which fermentation occurs.



How bacteria are genetically modified?

By genetic engineering.

- Genes are section of the DNA of an organism that code for a particular protein.
- Gene can be transferred successfully from one organism into bacterium, then genetically modified bacterium will now make the protein that its new gene code for.

-Genetic engineering become possible because of the development of three techniques

i. cutting gene out of DNA molecule using enzymes called *restriction endonuclease*.

ii. Inserting and tie gene into another molecule using *ligase enzyme*.

iii. Transferring gene into another cells using *Vectors*, such as plasmids, viruses, and gene gun.

Once a gene has inserted into bacterium, the bacterium become transgenic or genetically modified bacterium.

How plants can be genetically modified?

Many crop plants can be genetically modified by inserting foreign gene into them.

This gives the plants new traits, such as – resistant to diseases
- resistant to pest
- longer shelf life
- faster growth rate
- increase food quality

- Plants can be genetically modified in cellular levels during *cell (tissue) culturing* in laboratory under controlled conditions.
- Genetic engineering of plants become difficult to biologist because plant cells do not accept plasmid, as bacteria.
- Biologists discovered Agrobacterium tumefacein bacteria that regularly infect plant cells.
- Agrobacterium, acts as vector to carry genes that have been inserted into bacterium to cells of plants.
- But agrobacterium cannot be used to genetically modify all types of plants. i.e. agrobacterium cannot infect cereals, such as maize.
- To solve this problem, biologists developed a *gene gun* that used to shoot the gene in to cells of plant.
- Gene gun shoots bullets 'tiny pellets of gold' that are covered in DNA.
- Gene gun has made possible to genetically modify some plants such as maize, tobacco, potato, carrots, apple, soya been, etc.

Sewage treatment

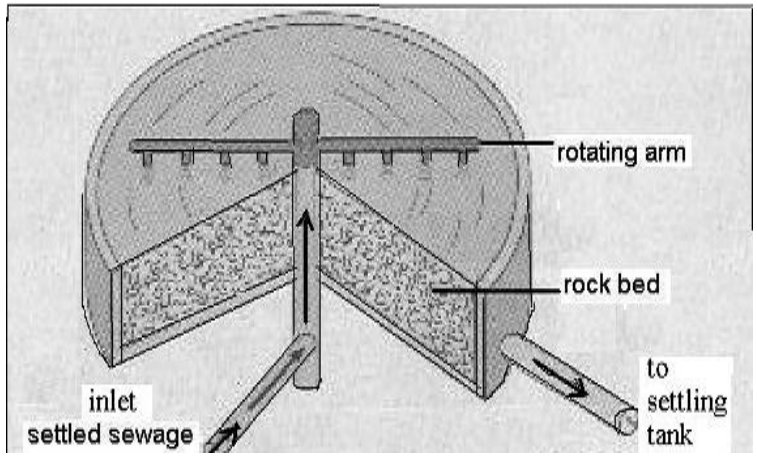
- All types of sewage treatment depend on the action of microorganisms to oxidize polluting organic present in sewage.

There are two main methods

1. Percolating filter methods
2. Activated sludge methods

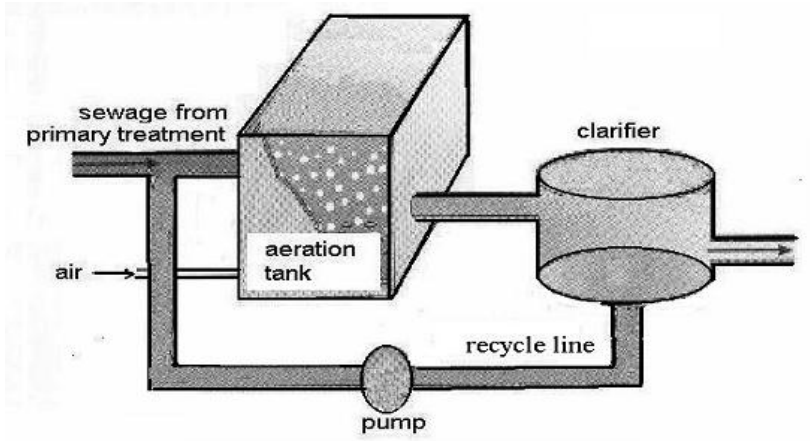
1. Percolating filter methods

- First sewage is screened to remove large pieces of debris and then stand in large settlement tank to allow suspended matter settle out.
- The sewage is allowed to trickle through beds of stones, w/c covered by large number of microorganisms(bacteria, fungi and protozoa).
- As the sewage trickles through the filter beds, the microorganisms digest the organic matter and absorb the products.
- When the liquid reaches the bottom of the filter bed, polluting organic matter has been removed.
- The treated sewage can be discharged into river.



2. The activated sludge method

- First the sewage is screened and allowed to stand in settlement tank, as in percolating filter method.
- The this is pumped into treatment tank, where
  - i. activated sludge, rich in microorganisms is added
  - ii. Oxygen is blown through mixture.
- In oxygenated mixture, the microorganisms from added activated sludge oxidize the polluting organic matter.
- Some of the sludge formed is recycled to seed tanks.



The role of bacteria in an ecosystem

- Bacteria play role in recycling of minerals in ecosystem.
- Many bacteria are decomposers (they breakdown complex molecules into much smaller molecules).
- Some simpler molecules are absorbed for bacterial metabolism, the other are released to the environment.
- Elements that recycled, are carbon, Nitrogen, sulphur, and phosphorous.

1. Nitrogen cycle

- The element nitrogen is found in many important organic molecules in all living organisms such as Protein, nucleic acids, and ATP.
- When organisms die, nitrogen contained by them made to other organisms.
- Several different types of bacteria are involved in the recycling of nitrogens.

The role of bacteria in Nitrogen cycle

1. Nitrogen fixation- nitrogen gas is fixed into NO_3 that needed by plants to make protein. Eg. Rhizobium
2. Ammonification- protein in dead organism and waste of animals are breakdown to release Ammonium (NH^+_4). Eg. Ammonifying bacteria
3. Nitrification: Occur with two steps.
   Eg. Nitrifying bacteria i. NH^+_4 —Nitrosomonas→ NO_2
   ii. NO_2 —Nitrobacter→ NO_3
4. Denitrification - reduce NO3 into Nitrogen gas returning nitrogen into air and reducing the amount of nitrogen in the soil.
   Eg. Denitrifying bacteria – Pseudomonas denitrificans

2. Sulphur Cycles

Sulphur is found in fewer types of organic molecules than nitrogen.

- is found in many protein

The role of bacteria in sulphur cycles

i. **Decomposition**- sulphur is released from protein of dead matter as H_2S, which give 'the rotten egg' smell.

Eg. Desulphovibro(Anaerobe)

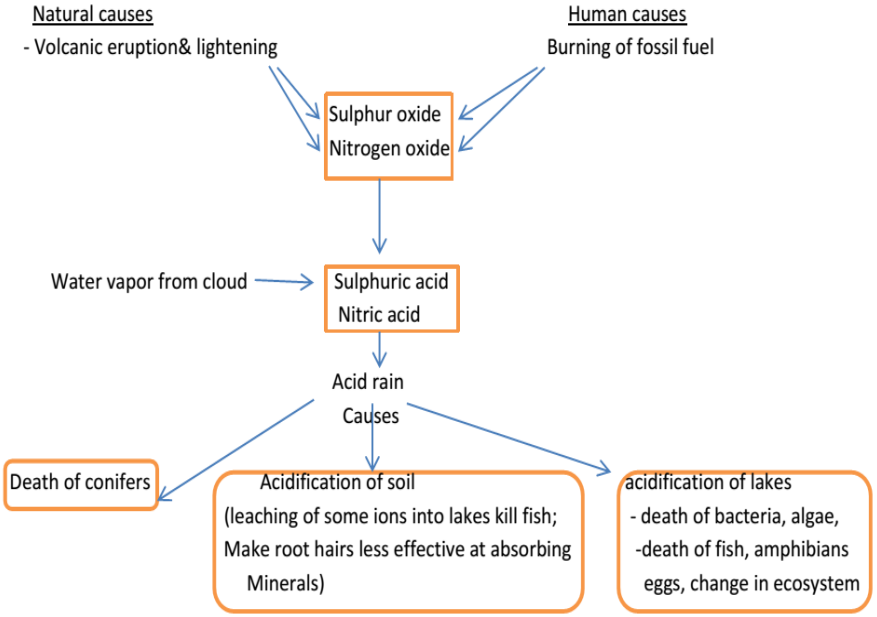
ii. **Oxidation of Hydrogen sulphide**- H_2S is oxidized to release sulphur

Eg. Photosynthetic sulphur bacteria (anaerobe)

iii. **Oxidation of sulphur** – suphur is oxidized to sulphate ion.

Eg. Non-photosynthetic sulphur bacteria(aerobes)

- If the population of bacteria that involved in Nitrogen and sulphur cycle were reduced, then the cycling of these elements could not occur.



Virology

1.3. What are viruses?

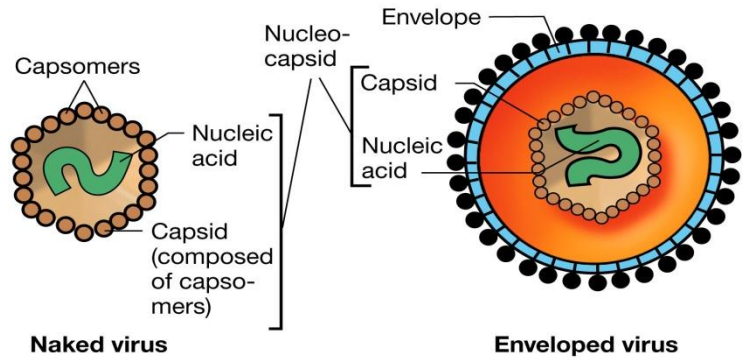
- A ***virus*** (Latin name coined by Martinus W. Bijernick , in 1898, meaning " *poisonous fluid*.")
- Viruses are biologically Ultramicroscopic entiries that exihibit the characteristics of non-living and living organisms. They are much smaller than smallest bacterium cell. Most are b/n 0.01 and 0.1µm in length. i.e. they are at least 1000 times smaller than the smallest bacterium and 1million times smaller than most human cells.
- Virus is simply genetic material (genome) contained in protein coat. They are not usually regard as living organism b/c they do not have the major organelles that present in living organisms. And they do not carry out any of the normal metabolic processes of cells such as respiration, protein synthesis, DNA replication, photosynthesis, active transport, etc.

Viral Structure

The intact viral unit (the basic infectious particles of virus)is known as **viron**.

There are two types of virons

1. simple viron(naked virus);-have nucleic acid and capsid
2. complex viron(enveloped virus);- have nucleic acid , capsid and envelope.



,

The **major components** of a virus are:

• **Nucleic acid core**. The *nucleic acid core* can either be DNA or RNA that makes up the genetic information (genome) of the virus. RNA genomes only occur in viruses.

• **Capsid**. A *capsid* is the protein coat that encapsulates a virus and protects the nucleic acid from the environment. It also plays a role in how some viruses attach to a host cell. A capsid consists of one or more proteins that are unique to the virus and determine the shape of the virus. Capsid is made of repeating sub-unit called *capsomers*.

Envelope. An *envelope* is a membrane bilayer that some viruses have outside their capsid. If a virus does not have an envelope, the virus is called a naked virus.

Viral infection

Virus is an obligate intracellular parasite that can only replicate inside a living host cell. They replicate solely by exploiting living cells based on the information in the viral genome. They have no metabolic systems of their own, but rather depend on the synthetic mechanism of a living host cell, whereby the viruses exploit normal cellular metabolism by delivering their own genetic information, i.e., nucleic acid, into the host cell.

Stages of viral infection of hosts

Depends on types of virons

i. for enveloped DNA virus (complex viron)

1. attachment(adsorbtion)
2. entry(penetration)
3. uncoating
4. Biosynthesis of enzymes
5. Destruction of nuclear DNA
6. replication
7. production of viral protein
8. assembly
9. Release of virus budding through host cell membrane.

ii. For simple viron (naked RNA virus)

1. attachment(adsorbtion)
2. Entry(penetration)
3. Uncoating
4. replication
5. Production of protein
6. Assembly(maturity)
7. Release of the virus rapturing the cell

Classification of virus

It is difficult to classify viruses though they have basic structure, b/c

i. the great variations in their shapes

ii. the great variation in the ways of infection

Based on nature of their genetic materials virus can be classified into three

1. DNA virus: eg. Herpes simplex, influenza, bacteriophage viruses, etc
2. RNA viruses: eg. H_1N_1viruses (swine flu), tobacco mosaic virus, polio virus, etc
3. Retroviruses: eg. HIV, SIV (Simian immunodeficiency virus), etc

1. DNA-viruses
   Have double stranded DNA
   During host infection, the viral DNA replicates itself and can control synthesis of protein as cellular gene.
   DNA------ DNA------RNA-------protein
2. RNA-viruses
   Most RNA viruses contain a gene for RNA-replicase enzyme.
   RNA replicase enzyme use RNA as template to make complementary new RNA strand.
   RNA--------RNA---------Protein
3. Retroviruses
   (RNA-DNA viruses)
   Contain RNA associated with unusual enzyme called reverse teanscriptase which use RNA as template to synthesis Double stranded DNA inside host.
   RNA-------DNA---------RNA--------protein

- All organisms store their permanent information in DNA, except RNA virus.
- DNA-virus uses RNA only as temporary storage.

The difference between DNA and RNA

DNA	RNA
- Is quite stable molecule and replicatevery accurately	- is quite unstable and make frequent mistakes during copying
- is not very reactive with other molecules	- is ideal for storage of viral information.

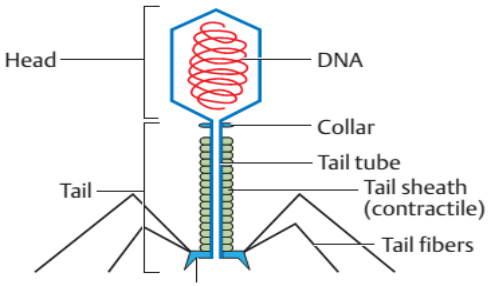
- The unstable nature of RNA, allow RNA-viruses to evolve for more rapidly than DNA viruses, frequently changing their surface structures.
- RNA viruses mutate more rapidly.

Viruses can be also classified into three based on the types of organism they infect.

1. Animal infecting viruses
2. Plant infecting Viruses
3. Bacteria infecting Viruses(Bacteriophage virus)

Virus multiplication or replication

- scientists learned multiplication of virus by studying bacteriophage viruses.
- Most common studied are T-groups(phages) such as T_1, T_2, T_3, T_4, T_5, T_6, etc.
- T-even(T_2, T_4, T_6) are virulent that kill their immediate host.
- T-odd(T_1or lamda phage, T_3, T_5) are temperate, do not kill their hosts.
- T-phages infect bacterium Escherichia coli, bacterium of human digestive system.
- Bacteriophage virus has double stranded DNA in its head part.



Bacteriophage virus can reproduce by

i. Lytic cycle – caused by virulent groups

ii. Chronic release cycle- caused by virulent groups

iii. Lysogenic cycle - caused by temperate groups

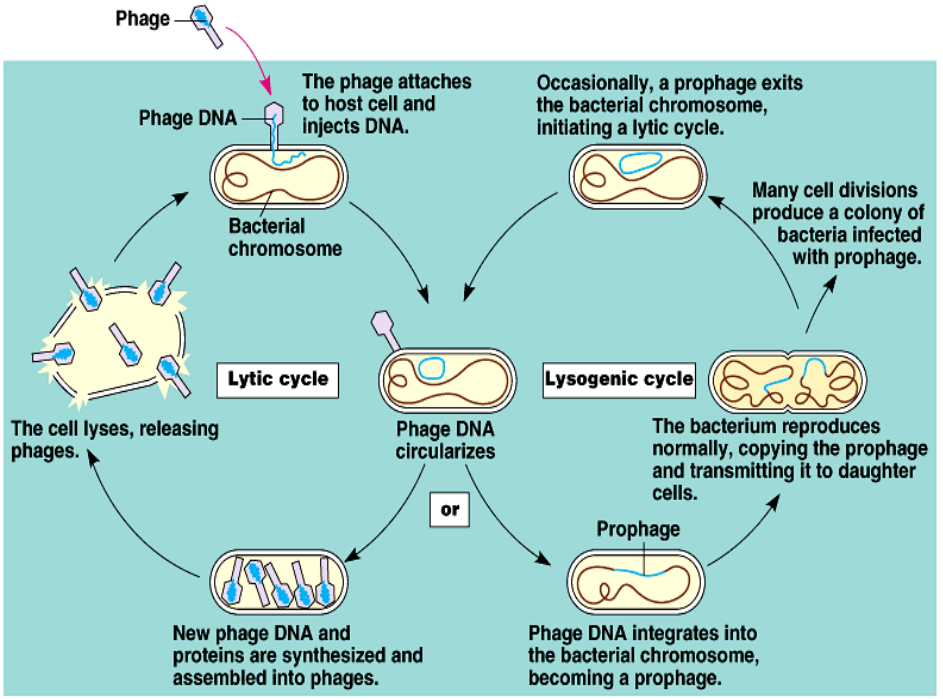
Lytic cycle- causes lysis or rapture of host cell, b/c all viruses released at once.

Chronic release cycle- few viruses are released by exocytosis through the plasma membrane at a time.

- release new viruses gradually.

Lysogenic cycle- viral DNA become incorporated with DNA of host cell. The viral DNA that integrated to ho host DNA is called prophage, w/c is inactive. During cellular reproduction, the host cells copies the prophage along with its cellular DNA. After many repeated cell division of bacteria, prophage and cellular DNA pass into daughter cells. But some factors of environmental constraint, triggers prophage breakdown from bacterial DNA by excisionase enzyme. The excision process leads to either lytic or chronic release cycle.

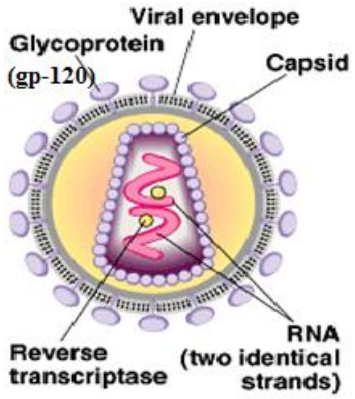
Lytic and Lysogenic cycle



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HIV and AIDS

- HIV *(Lentivirus) human immunodeficiency virus* is a virus that often results in acquired immunodeficiency syndrome (AIDS) This virus targets CD4 (T-cells)of the T-lymphocytes.
- T-lymphocytes are WBC developed in the bone marrow, unlike B-cells, express anti-bodies on its surfaces, i.e. do not secrete antibodies.
- T-cells help white blood cells that fight infection.
- HIV-has spikes on its surface, the head of spike made of glycoprotein known as gp-120. One spike made of three gp-120 and gp-41.
- During infection gp-120 binds with CD4 receptor protein that protrude from T-helper cells.
- Besides the T-helper cells there are other types of cells that carry CD4-receptor on their surfaces(macrophages & other killer cells)

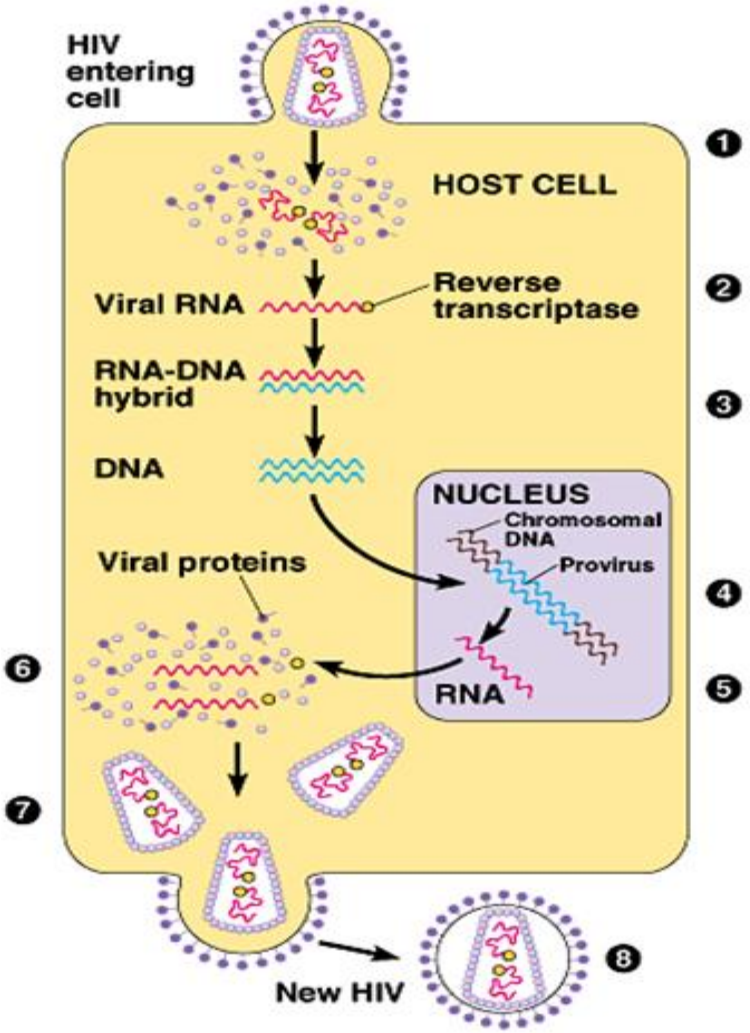


The structure of HIV, the virus that causes AIDS

How does HIV reproduce and cause AIDS?

After HIV has bound to CD4 receptor on surface of T-helper cells, the following events occur:

1. It fuse (attach) with the plasma membrane, and then Viral RNA & reverse-transcriptase enclosed in capsid enter into the host cells.
2. The reverse-transcriptase converts RNA into DNA using nucleotides of the host cells.
3. The viral DNA becomes incorporated into host DNA and become **provirus**.
4. The viral DNA transcribed to viral RNA, which start producing viral proteins CD4 receptors, capsids, and enzymes such as protease and reverse-transcriptase.
5. The RNA, Proteins and reverse-transcriptase are assembled by the cells into new viral particles that escape by budding off through plasma-membrane.
6. The viruses then infect other cells.



The reproductive cycle of HIV

- Because the envelope remain on the surface of infected cells, they become detected (recognized) by killer cells of immune system, and then killer cells destroy infected cells.
- The cycle of infection, reproduction, and destruction of infected cells repeated itself for as long as the body keep-replacing the CD4 lymphocytes.

- Eventually the body will not be able to replace T-cells and the number of free viruses, in the blood will increase dramatically.
- The period when the body keep-replacing the CD4-lymphocytes as fast as they are destroyed is called **latency period,** can last for many years.
- Because destruction of T-helper cells (esp. CD4 count below 200cells per µl of blood) the immune become compromised or weakened. Then the body exposed to **opportunistic infections** in AIDS patients such as
  - *Kaposi's sarcoma*, which is a rare form of cancer,
  - candidiasis,
  - herpes zoster,
  - pneumonia
  - leishmaniasis
  - tuberculosis

Can be AIDS treated?

- There is no cure for AIDS and no vaccine to give immunity,
- But there are number of drugs called Anti-retroviral drugs that can be effective in slowing down the progression of AIDS.
- These drugs work by blocking the reproduction of viruses acting on different stages of life cycle the virus in the CD4 lymphocytes.
- **HAART**(highly active anti-retroviral therapy)-is combined treatment that uses different drugs together acting on different stages of HIV-life cycle.
  1. **Entery inhibitor drugs**: attaches to protein on the surface of T-cells or HIV to prevent the two from joining.
  2. **Nucleotide reverse-transcriptase inhibitor drugs(AZT):** are faulty versions of building blocks (Nucleotides), prevent conversion of RNA to DNA.
  3. **Non-nucleotide reverse-transcriptase inhibitor drugs:** attach to HIV enzyme preventing it from converting RNA to DNA.
  4. **Protease inhibitor drugs:** interfere with action of HIV's protease enzyme preventing the assembly of new viral particles.

- There is no AIDS vaccine because
  - – Viruses mutate regularly
  - Viruses reproduce in immune cells themselves.
  - Viral DNA remains hidden in host cell DNA for many years.