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Medical Biology

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By the name of God

Medical Biology

Lec: 1

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Introduction

Biology is derived from two Greek words: Bios=living and logos=study. Thus, biology is defined as a science that deals with study of living organisms.

Aristotle is regarded as "father of Biology". Biology mainly deals with plant and animal kingdom. Broadly, biology is divided into two branches. They are listed below:

1) Zoology:

Zoology is a branch of biology that deals with the study of animal kingdom. Father of zoology is Aristotle.

2) Botany:

Botany is branch of biology that deals with the study of plant kingdom. Father of botany is Theoprastus

What Is Biology?

Biology is a science that deals with the study of life organisms. It is a broad field including many branches. . Biologists study structure, function, growth, evolution, distribution, identification and taxonomy. Below are the main branches of study included in this field.

The Main Branches of Biology

- *Anatomy is a branch of biology that deals with the study of internal structure of living organism*

• *Bacteriology is a branch of biology that deals with the study of bacteria.*

• *Biochemistry is a branch of biology that deals with the use of chemistry in the study of living things.*

• *Cytology is a branch of biology that deals with the study of cells microscopic molecules.*

• *Ecology is a branch of biology that deals with the study of the relationships between the organism and its environment and between the organism and others.*

• *Embryology is a branch of biology that deals with the study of the formation and development of living things from fertilization to birth*

Or : *Is the science that deals with the study of developmental patterns of organisms from zygote to birth.*

• *Endocrinology is a branch of biology that deals with the study of hormones.*

• *Entomology is a branch of biology that deals with the study of insects.*

• *Epidemiology is a branch of biology that studies health of populations.*

Genetics is a branch of biology that studies heredity and the lifelong development of living organisms.

Or -.Genetic: *A science that studies how feature passed to offspring from their parents.*

• Histology is a *branch of biology that deals with the study of microscopic structure of tissues*

• Helminthology is a *branch of biology that studies worms.*

• Herpetology is a *branch of biology that studies reptiles and amphibians.*

• Ichthyology is a *branch of biology that deals with the study of fish.*

• Limnology is a *branch of biology that deals with the study of inland waters.*

• Mammalogy is a *branch of biology that deals with the study of mammals.*

• Marine biology is a the study of ocean ecosystems.

• Microbiology is a the study of microorganisms.

• Molecular biology is a the study of biological functions at the molecular level.

Morphology: is the science that deals with the study of phenotype and form of living organism (shape),

• Mycology is a the study of fungi.

• Ornithology is a the study of birds.

• Pathology is a the study of diseases, generally in human and animals.

• Physiology: is the science that studies the functions of tissues and organs.

• Pharmacology is a the study of the actions of chemicals matter on Or within living organisms.

• Phycology is a the study of algae.

• Protozoology a is the study of one-celled organisms.

• Taxonomy is a the study of the classification and naming of living things.

• Virology is a a the study of viruses.

Classification Of Kingdom

Kingdom -----Phylum-----Class-----Order-----Family-----
Genus-----Species.

Ex: Human

Kingdom-----Animalia

Phylum-----Chordate

Class-----Mammalia

Order-----Primate

Family-----Homonidae

Genus-----*Homo*

Species-----*sapiens*

Sub species-----Africans, Europe etc

Prokaryotic and Eukaryotic

Prokaryotic:

The characteristics:

1. Single celled organisms.
2. Lacking membrane nucleus.
3. Such as: Bacteria and Cyano phyta (Algae).
4. Cell size :small
5. Cell wall: rarely are walled
6. Metabolism: Aerobic, Anaerobic

7. Genetic materials: bacterial chromosome, plasmid.

8. Mode of division: Binary fission, budding.

Eukaryotic:

The characteristics:

1. Single celled or multi celled organisms.

2. Definitive nucleus and membrane organisms

3. Such as : Fungi, Plantae, Animalia /

4. Cell size: large

5. Cell wall: Cellulose or chitin,

6. Metabolism: Aerobic.

7. Genetic materials: complex chromosome with a nucleus.

8. Mode of division: nuclear division and cytoplasmic division.

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Bacteria

Introduction

Bacteria are the oldest structurally simplest and the most abundant form of life on the earth. Bacteria can be found in every eco system on earth They are only organisms. They estimated 5×10^{30} bacteria on earth.

They are unicellular micro organisms ranging in length from 0.5 to 1 micrometer. They play a vital role in productivity and cycling the essential substances to all other life form. The bacteria are the only organisms that capable of fixing nitrogen.

Bacteria can be found in the following shapes:

Round shape (coccus).

Rod shape (bacillus).

Twisted in one time (vibrio).

Twisted in more times (spirillum).

The history of bacteria

Bacteria were first observed by Anton Van Leevenhook in 1676. The term "bacteria" is Greek, it means "small stuff". It was first used in 1838. Robert Koch and Lewis Pasteur were the first to discover that bacteria which caused many diseases (mid 19th century) The first antibiotic used to treat bacteria diseases was made by Paul Erich in 1910, it was used to treat syphilis. 7

The cell wall of bacteria

A cell wall usually surrounds plasma membrane. The cell wall is a semi rigid, permeable structure which helps a cell to maintain shape and resist rupturing when internal fluid pressure rises.

The cell wall is made of **peptidoglycan** (poly saccharides molecules connected by polypeptide cross- links).

Glycocalyx (streaky mesh)

The streaky mesh often encloses the wall . It consists of poly saccharide, polypeptide or both. When highly organized, and firmly attached to the wall such mesh is known as a capsule. When less organized, loosely attached to the wall, it is called slimy layer.

The mesh helps a bacterium to attach to teeth, mucous membrane, rocks in streams and one other interesting surfaces.

The mesh also helps some encapsulated types to resist being engulfed by phagocytic infection fighting cells of the host species.

Flagella in bacteria

Some bacteria have one or more flagella. The motile bacteria can be classified according to number and location of their flagella in to five categories;

1. **Monotrichous:** which with one flagellum on either end such as *Pseudomonas aeruginosa*.
2. **Lophotrichous :** which with a tuft of flagella on one end such as: *Pseudomonas fluorescens*

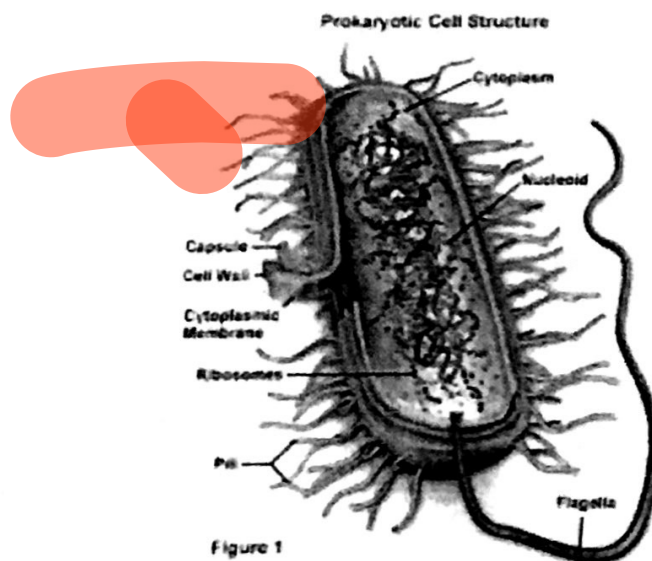
3. **Amphitrichous:** which with a tuft of flagella on both ends such as: *Aquaspirillum serpens*
4. **Holotrichous** (peritrichous) which with flagella distributed all over the body such as : *Salmonella typhi*
5. **Atrichous:** which do not have any flagellum on the body such as coccus.

Pilli:

Many types of bacteria have Pilli . which are short ,filamentous projections above the wall. Pilli help the bacteria to adhere to surface or to another bacteria as a prelude to conjunction.

Nucleus

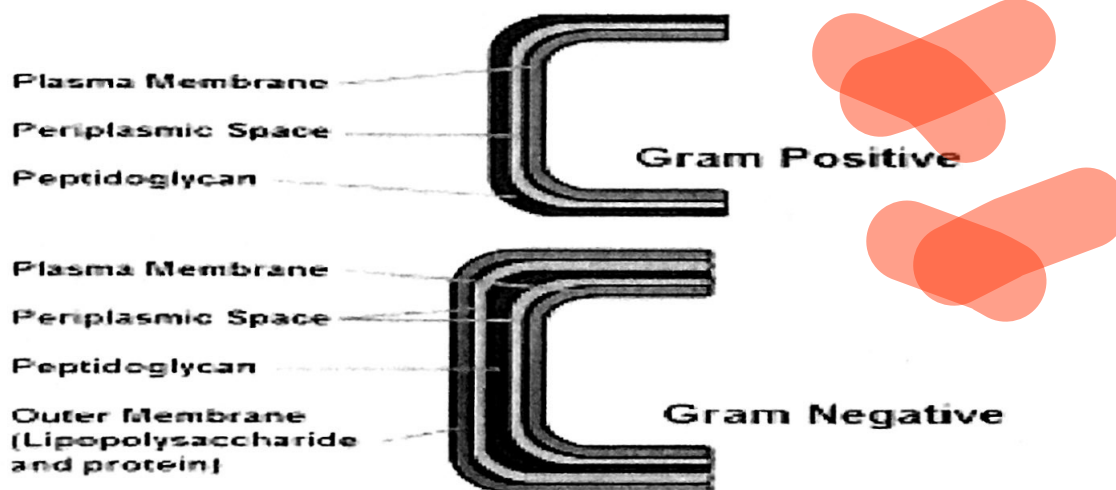
Bacteria do not have a nucleus .Their DNA . which is cellular ,is free in the cytoplasm . The cytoplasm contains neither organelles except ribosome.



Gramstain

The gram 's stain is the first test done to identify bacteria . The gram ' s stain is different between two major cell wall types gram positive and gram negative . In gram positive bacteria the peptidoglycan layer of bacteria cells is much thicker than in gram negative ones .

In more common gram negative bacteria , large molecules of lipopolysaccharide layer are deposited over the peptidoglycan, forming an outer membrane, this lipopolysaccharide layer makes gram negative bacteria resistant to many antibodies to which gram positive ones are susceptible.



Gram positive :

Gram positive bacteria have walls containing relatively large amount of peptidoglycan, such as *Staphylococcus epidermises* *Streptococcus progenies* *Bacillus anthraces* (Anthrax).

Gram negative :

Gram negative species have walls containing small amount of peptidoglycan and a lipopolysaccharides (fat, sugar), such as: *Escherichia coli*,

Salmonella typhi and *Vibrio cholera*. Gram negative bacteria are harder to control with antibiotics .

The steps of gram stain:

Gram stain has four steps:

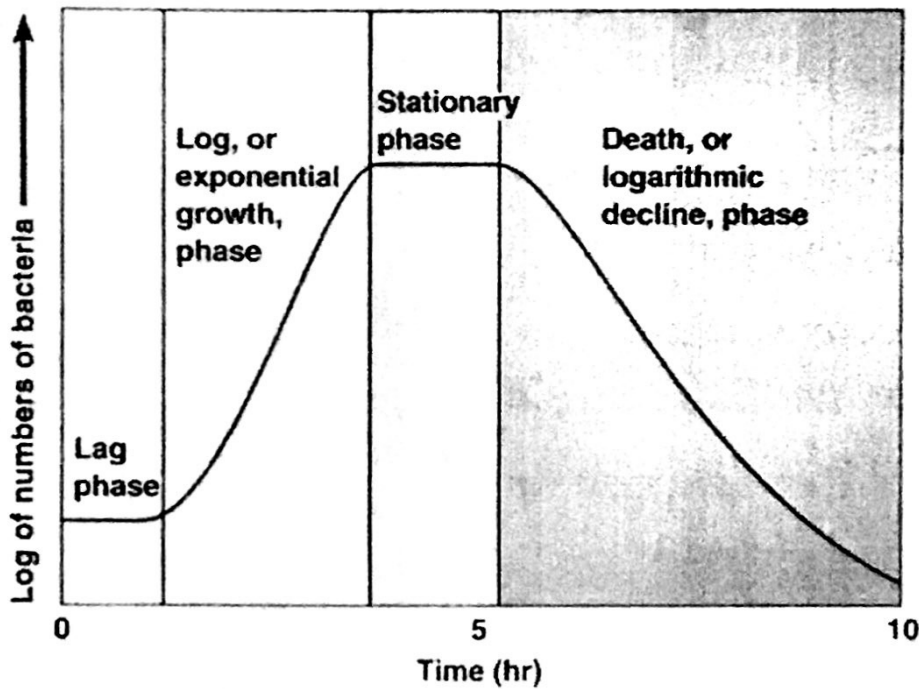
1. Crystal violet ,the primary stain .
2. Iodine which acts as a mordant by forming a crystal violet iodine complex .
3. Alcohol, which decolorizes
4. Safranin , which the counter stain .

G + organisms are (purple) .

G – organisms are red .

Bacterial growth

1. Lag phase : bacteria growing slowly (preparing to growth).
2. Logarithmic phase : exponential growth.
3. Stationary phase : (mortality equal natality).
4. Death phase: nutrient get used up.



Nutrition

- There are three modes of nutrition. Bacteria are classified as:
1. Phototrophs : (capable of utilizing carbon dioxide to build their food through photosynthesis.
 2. Chemotrophs: (capable of getting electron from ammonia as in nitrifying bacteria).
 3. Heterotrophs: capable of degrading organic molecules of dead organisms and have roles as decomposers.

- 1, 2, 3
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Reproduction of Bacteria

Most bacteria are able to reproduce asexually and sexually. Asexual reproduction occurs either mostly by simple binary fission.

Sexual reproduction occurs by bacterial conjugation through which a donor cell transfers plasmid DNA, to recipient cell.

So, some bacterial are able to form thick walled endospore around their chromosome and a small portion of the surrounding cytoplasm when they are exposed to drying condition or highly temperature etc, such endospores are highly resistant to environmental stress and can germinate to form new bacterial individuals after decades or even centuries.

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Bacterial and diseases

Although the great majority of bacteria play a positive role in human life forms, some bacteria are pathogenic (disease causing)to plants and animals. In humans, bacteria cause many diseases acquired with consumed food and drinks or through inhalation, such as dental caries, cholera, bacillary dysentery, tuberculosis, bacterial pneumonia and whooping cough . Some bacterial species are responsible for some sexually transmitted diseases (STD) such as gonorrhoea, syphilis and Chlamydia, which are acquired through sexual intercourse, or any other sexual contact (oral or anal intercourse) in which body fluids are exchanged

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Viruses

Viruses bridge the gap between the living and the non living. Outside a host ,viruses are essentially chemicals that can be stored on a shelf. But when opportunity arises, viruses replicate inside cells and during this period, they clearly appear to be alive.

Viruses are cellular --not composed of cells. They are parasites and do not live independently. Viruses cause diseases such as colds, flu, measles, .chicken pox ,polio rabies, AIDS, genital warts, and genital herpes.

Virus particles are about one-quarter

the size of a bacterium, about

one hundredth the size of a eukaryotic cell .A virus always has two parts : an outer capsid composed of protein units and an inner core of nucleic matter.

A virus carries the genetic information needed produce it self. In contrast to cellular organisms, the viral genetic material need not be double-stranded DNA, nor even DNA.

Indeed, some viruses, such as HIV and influenza, have RNA as their genetic material. A virus may also contain various enzymes that help it repro duction

Consist of :

1.nucliec acid (DNA)

2. portion coat or sheath .

3. Sometimes an inter envelope.

Virus's diseases

Small pox, chicken pox, German measles(rubella), pumps, viral encephalitis, influenza, infectious hepatitis, rabies yellow fever and AIDS, cancers and leukemia's.

Multiplication cycles of virus:

1. Attachment to suitable host.

2. penetration of it.

3. RNA or DNA replication .

4/Assembly of new viral particles.

5. Release.

Bacteria phages:

Group of viruse that infect bacterial cells. They are used in experiments to determine the function of DNA, they are used as a tool in genetic engineering.

Some bacteria phages consist only DNA , protein coat (sheath).

Immunity

^{imp} Immunity: is the ability of an organism to resist diseases, either through the activities of specialized blood cell or antibodies produced by them in response to natural exposure or inoculation (active immunity) or by the injection of antiserum or the transfer of antibodies from a mother to her baby via the placenta or breast milk.

Immune system

Immune system that enables us to resist infections. The immune system is composed of two major sub division:

^{imp} 1. The innate immune system or non-specific immune system, which is our first line of defense against invading organisms .

^{imp} 2. The adaptive immune system or specific immune system which acts as a second line of defense and also affords protection against re-exposure to the same pathogen.

The immune system protects the body against

disease or other potentially damaging foreign bodies. When functioning properly, the immune system identifies and attacks a variety of threat, including virus, bacteria and parasites, while distinguishing them from the body's own healthy tissue.

The lymphatic system consist of bone marrow, spleen, thymus and lymph nodes. Bone marrow produces white blood cell or leukocytes. The spleen is the largest lymphatic organ in the body contains white blood cells that fight infection or disease.

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The thymus is where T-cells mature, T cells help destroy infected or cancerous cells. Lymph nodes produce and store cells that fight infection and disease.

Lymphocytes and leucocytes are small white blood cells that play a large role in defending the body against disease. The two types of lymphocytes are B cells which make antibodies that attack bacteria and toxins, and t cells, which help destroy infected or cancerous cells

General features of innate and adaptive immunity

Although the innate and the adaptive immune system both function to protect against invading organisms, they differ in a number of ways.

First, the adaptive immune system requires some time to react to an invading organism whereas the innate immune system includes defenses that, for the most part, are present and ready to be mobilized upon infection. Second, the adaptive immune system is antigen specific and reacts only with the organism that induced the response. In contrast, the innate system is not antigen specific and reacts equally well to a variety of organisms. Finally, the adaptive immune system demonstrates immunological memory. In contrast, the innate immune system does not demonstrate immunological memory. All cells of the immune system have their origin in the bone marrow.



The First Line of Defense (nonspecific)

1. Skin.

2. Mucous Membrane and their secretion.

* Stomach acid

* Mucous

* tears

* Urine

The Second Line of Defense (non specific)

1. Phagocytic white blood cells

* neutrophils

* monocytes

* eosinophils

2. Antimicrobial protein

* complement

* cytokines

* interferon

3. The inflammatory response and fever

* histamines

* cytokines

The third line of defense (specific mechanisms)

* Lymphocytes (cellular response)

* B – cells- antibodies.

* T-cells help stimulate B cells.

What is the immunology

The study of how the body defends itself against foreign organisms such as bacteria, viruses, parasites and fungi, as well as against foreign non-invasive cells, tissues, molecules.

Immunity in the oral cavity

The oral cavity is the port of entry for many pathogens, food and drugs which can trigger an immune response.

Transient components: Dead pathogens, allergens, food.

Persistent components: Live pathogens that colonize the oral cavity.