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MAINLAND LECTURE CENTER

BIO217: GENERAL MICROBIOLOGY

Microorganisms are organisms too small to be seen clearly by the unaided eyes

___ are very small life forms so small that individual microorganisms cannot be seen without magnification

Microorganisms

Examples of microorganisms are _

fungi, bacteria, algae, protozoa and viruses

The **cell** is the fundamental unit of life

a **single cell** is an entity isolated from other cells

there are ___ fundamental different types of cells exist among microorganisms

Two

there are Two fundamental different types of cells exist among microorganisms which are___

prokaryotic and eukaryotic

Prokaryotes are microbial cells lack membrane-bound nucleus and organelles.

Eukaryotes Possess a membrane-bound nucleus and organelles

Based on cell type and mode of nutrition, there are the five kingdom system of classifying organisms which are___

- **Monera**
- **Protista**
- **Fungi**
- **Planta**
- **Animalia**

through advances in cell biology, biochemistry and genetics, microorganisms are now placed into three domains which are___

- **Bacteria (prokaryotic – “true bacteria”)**
- **Archaea (prokaryotic – “ancient bacteria”)**
- **Eucarya (eukaryotic)**

The characteristics of domain bacteria are___

- **They are prokaryotic.**
- **They are single celled organisms.**
- **They lack membrane bound nucleus and organelles.**
- **Most have cell wall that contains peptidoglycan.**
- **They are found in the soil, water and air and on other living organisms.**
- **Some are harmful while others are beneficial to man.**

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The characteristics of domain Archaea are__

- They were formerly known as archaeobacteria.
- They are prokaryotic.
- They are single celled organisms.
- They lack membrane bound nucleus and organelles.
- They lack peptidoglycan in their cell walls.
- They have unique membrane lipids.
- Some have unusual metabolic characteristics, e.g. methanogens which generate methane gas.
- Many are found in extreme environments

Domain archaea is distinguished from bacteria based upon__

- Differences in ribosomal RNA sequences.
- The absence of cell wall peptidoglycan.
- The presence of unique membrane lipids.

The major groups of microorganism in domain Eucarya are__
protists and fungi

__are groups of microorganisms are unicellular algae, protozoa, slime moulds and water moulds

Protist

The Characteristics of algae are__

- They are simple organisms.
- Mostly unicellular.
- They are photosynthetic together with cyanobacteria.
- They produce about 75% of the plant's oxygen.
- Commonly found in aquatic environment.
- They are primary producers in food chains in aquatic habitat.

The characteristics of Protozoa are__

- They are unicellular.
- Eukaryotic organisms and animal like.
- They are usually motile.
- Some are free living while some are pathogenic.

__are protists that At a stage they are like protozoa and at another stage like fungi.

Slime mould

__are found on the surface of fresh water and moist soils.

Water Moulds

__feed on decaying vegetation such as logs and mulch.

Water Moulds

The characteristics of Fungi are__

- These are microorganisms that range from unicellular forms like yeasts to moulds and mushrooms which are multicellular with thread like structures called hyphae.
- They absorb nutrients from their environments.
- Many play beneficial roles while others cause diseases in plants, animals and human.

The characteristics of Viruses are__

- They are acellular entities (non cellular).

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- They lack the fundamental structure of living cell but only carry out functions of living organisms when in living cells.
- They are the smallest of all the microorganisms (10,000 smaller than a typical bacterium).
- They can only be seen by the electron microscope.
- They cause many diseases of plants, animals and humans.
- Entities are not placed in any of the domain but are classified on a separate system

Microbiology is the study of microorganisms, most of which are unicellular while some are multicellular

Viruses are classified under a separate system because____
they function only as living things when present in living organisms.

microorganisms may be **prokaryotic** which lack a membrane bound nucleus or **eukaryotic** which have a membrane bound nucleus but undifferentiated tissues

microorganisms are grouped into **three** domains which are____
bacteria, archaea and eucarya

the domain bacteria and archaea are **simple and prokaryotic microorganisms** While the domain eucarya consists of the protists and fungi which are **eukaryotic microbes**

____are acellular entities and are not placed in any of the domain but are classified on a separate system.
viruses

The **history of microbiology** is the story of men and women who developed a technique, a tool or a concept that was generally adopted in the studying of microorganisms

The advent of the ____permitted the studying of microorganisms.
Microscope

The first microscopes were **simple ground glass lenses** that magnified images of previously unseen microorganisms.

____ coined the term “cells” to describe the “little boxes” he observed in examining cork slices with a compound microscope.

Robert Hooke (1635-1703)

____ was the first to make a known description of microorganisms.

Robert Hooke (1635-1703)

____ made microscopic observation and the earliest description of many fungi.

Robert Hooke (1635-1703)

The Various species of fungi were clearly identified in Robert Hooke’s drawing and recorded in his book **Micrographia**

Anthony Van Leeuwenhoek (1632-1723) lived in____, Holland.

Delft

____ learned lens grinding as a hobby and made over 100 simple microscopes each capable of magnifying an image about 300 times

Anthony Van Leeuwenhoek

By using simple microscopes, Anthony Van Leeuwenhoek observed microscopic organisms which he called ____

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'animalcules'

Bacteria was discovered in ____
1676

____ discovered bacteria in **1676** while studying pepper water infusion and reported his observations in a series of letters to Royal Society of London which published them in 1684 in English translation.

Anthony Van Leeuwenhoek

____ is known as the father of bacteriology

Anthony Van Leeuwenhoek

____ was the first person to publish extensive and accurate observations of microorganisms.

Anthony Van Leeuwenhoek

The concept spontaneous generation states that ____
living organisms could develop from non-living matter.

The proponents of the concept of spontaneous generation claim that ____
living organisms could develop from non living or decomposing matter.

Francesco Redi (1626-1697) challenged this concept by showing that maggots on decaying meat came from fly eggs deposited on the meat, and not from the meat itself.

____ conducted an experiment in which he divided a hay infusion that had been boiled into two containers: a heated container that was closed to the air and a heated container that was freely open to the air

Louis Jablot (1670)

John Needham (1713-1781) showed that mutton broth boiled in flasks and then sealed could still develop microorganisms, which supported the theory of spontaneous generation.

Lazzaro Spallanzani (1729-1799) showed that flasks sealed and then boiled had no growth of microorganisms, and he proposed that air carried germs to the culture medium

Louis Pasteur (1822-1895) was a Professor of ____
Chemistry

____ devised a series of swan necked flasks known as Pasteur-flasks, filled the flasks with broth and heated the broth to sterilisation.

Louis Pasteur

____ work led to an effective sterilization method which involve holding juices and milk at 62.8OC (145O F) for 30 minutes known as Pasteurization.

Pasteur's

____ discovered that alcoholic fermentation was catalyzed by Living Yeast Cells

Louis Pasteur

Louis Pasteur developed vaccines for the diseases anthrax, fowl cholera and rabies between **1880 and 1890.**

____ postulated the Germ Theory of Disease which states that microorganisms are the cause of infectious diseases.

Louis Pasteur

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___ work ushered in the Golden Age of Microbiology

Pasteur's

Agostino Bassi (1773-1856) showed that a ___ disease was caused by a **fungus**.

Silkworm

M. J. Berkerley (ca. 1845) demonstrated that the great potato blight of Ireland was caused by a fungus.

Joseph Lister (1872-1912) developed a system of surgery designed to prevent microorganisms from entering wounds.

Robert Koch was a ___ physician

German

___ was the first to directly prove the role of microorganisms in causing diseases.

Robert Koch

Koch discovered causative organisms of anthrax (1876), tuberculosis (1882) and cholera (1883).

___ was the first to grow bacteria on solid culture media to get pure culture

Koch

Koch's discovery of solid culture media and pure culture concept supplied the most needed tools for the development of microbiology as a field of science.

Edward Jenner (ca. 1798) used a vaccination procedure to protect individuals from smallpox

Emil Von Behring (1854-1917) and **Shibasaburo Kitasato (1852- 1931)** induced the formation of diphtheria tetanus antitoxins in rabbits which were effectively used to treat humans, thus demonstrating humoral immunity.

Martinus Beijerinck was a Professor at the **Delft Polytechnic**

___ isolated the first pure culture of many soil and aquatic microorganisms, including sulphate reducing and sulfur oxidizing bacteria, nitrogen fixing root nodule bacteria

Martinus Beijerinck

___ described the first virus and the basic principles of virology.

Martinus Beijerinck (1851-1931)

___ proposed the concept of chemo-lithotrophy

Sergei Winogradsky (1856-1953)

___ worked with soil bacteria and discovered they could oxidise iron, sulphur and ammonia to obtain energy

Sergei Winogradsky

Microbiology established a closer relationship with other disciplines during the ___ because of its association with genetics and biochemistry.

1940s

George W. Beadle and Edward L. Tatum (ca. 1941) studied the relationship between genes and enzymes using the bread mould, *Neurospora*.

Salvadore Luray and Max Delbruck (ca. 1943) showed that mutations were spontaneous and not directed by the environment.

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Oswald T. Avery, Colin M. Mcleod, and Maclyn McCarty (1944) provided evidence that deoxyribonucleic acid (DNA) was the genetic material and carried genetic information during transformation

THE Era of Molecular Microbiology Began in the ____
1970s.

The Era of Molecular Microbiology includes__

- **Advancement in the knowledge of bacterial physiology, biochemistry and genetics**
- **Genetic manipulation which involves the transfer of DNA from one organism into another or a bacterium and the proteins encoded by the DNA harvested led to the development of the field of Biotechnology.**
- **DNA sequencing revealed the phylogenetic (evolutionary) relationships among bacteria which led to revolutionary new concepts in microbial systematic.**

In **1990s**, DNA sequencing gave birth to the field of **genomics**.

Robert Hooke (1635-1703) and **Anthony Van Leeuwenhoek (1632-1723)** contributed to the discovery of microorganisms through the use of microscope

Experiment by **Francesco Redi and others** disproved the theory of spontaneous generation.

____defeated the theory of spontaneous generation
Louis Pasteur

Robert Koch developed postulate to establish relationship between a suspected microorganism and disease

Serge Winogradsky and **Martinus Beijerinck** discovered microbial effect on organic and inorganic matter both of them pioneered the use of enrichment culture and selective media.

George Beadle and others contributed to the development of microbiology

In the **twentieth century**, era of molecular microbiology began in the 1970s and led to the field of biotechnology.

In the **1990s**, DNA sequencing gave birth to the field of genomics.

There are **two** main branches of microbiology

There are two main branches of microbiology which are__

- **Basic**
- **Applied**

The basic branch of **microbiology** is concerned with the study of the biology of microorganisms

____is the study of **bacteria**
Bacteriology

____study of fungi such as yeasts, molds, and mushrooms
Mycology

____is The study of algae.
Algology

____is The study of protozoa

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Protozoology

a branch of protozoology called **parasitology** deals exclusively with the parasite or disease producing protozoa and other parasitic micro and macro organisms

Microbial Cytology Studies the structures of microbial cells

Microbial Physiology Studies of the nutrients that microorganisms require for metabolism and growth and the products that they make from nutrients.

Microbial Genetics Focuses on the nature of genetic information in microorganisms and how it regulates the development and functions of cells and organisms

The study of microorganisms in their natural environment is **Microbial Ecology**

___ also studies the global and local contribution to nutrient cycling. In addition, it employs microorganisms in bioremediation to reduce pollution.

Microbial Ecology

Microbial Taxonomy is the study of the classification of microorganisms or the grouping of microorganisms.

___ deals with the discovery of microbial enzymes and the chemical reactions they carry out.

Biochemistry

Medical Microbiology Studies of the causative agents of diseases, diagnostic procedures for identification of the causative agents and preventive measures

Agricultural Microbiology is the study of microbial processes in the soil to promote plant growth

___ involves the study of soil microorganisms which has led to the discovery of antibiotics and other important chemicals.

Agricultural Microbiology

___ also deals with the methods of combating plant and animal diseases caused by microbes, methods of using microbes to increase soil fertility and crop yields.

Agricultural Microbiology

Industrial Microbiology is the large scale growth of microorganisms for the production of medicinal products such as antibiotics and vaccines; fermented beverages; industrial chemicals; production of hormones and proteins by genetically engineered microorganism.

Aquatic and Marine Microbiology deals with microbial processes in lakes, rivers, and the oceans.

___ also examines issues that concern water purification, microbiology examination and biological degradation of waste.

Aquatic and Marine Microbiology

___ is closely related to medical microbiology

Public Health Microbiology

___ deals with the identification and the control of the spread of communicable diseases.

Public Health Microbiology

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___ involves monitoring of community food establishments and waste supplies so as to keep them safe and free from infectious agents

Public Health Microbiology

Immunology Deals with how the immune system protects the body from pathogens and the response of infectious agents

___ also involves practical health problem such as the nature and treatment of allergies auto-immune diseases like rheumatoid arthritis

Immunology

Food and Dairy Microbiology Deals with the use of microbes to make foods such as cheese, yoghurt, wine and beer.

___ also deals with the methods of preventing microbial spoilage of food and the transmission of food-borne diseases such as Botulism and Salmonellosis

Food and Dairy Microbiology

Aeromicrobiology Advances thought in the dissemination of diseases in the air, contamination and spoilage

Exomicrobiology involves Exploration for life in outer space

Coal, mineral and gas formation; prospecting for deposits of coal, oil and gas and recovery of minerals from low-grade ores is referred to as ___

Geochemical Microbiology

___ is the study of organisms too small to be seen distinctly with the unaided eyes.

Microbiology

Microscopes provide magnification which enables us to see microorganisms and study their structures

A ___ is an instrument for producing enlarged images of objects too small to be seen unaided

Microscope

There are **two** types of microscope which are ___

Light (optical) and electron

The ___ is a type of microscope in which magnification is obtained by a system of optical lenses using light waves

Light Microscope

Examples of light microscope are ___

- **Bright Field Microscope**
- **Dark Field Microscope**
- **Fluorescence Microscope**
- **Phase Contract Microscope**

The ordinary microscope is called a **bright field microscope** because it forms a dark image against a brighter background.

The **dark field microscope** is used to observe living unstained cells and organisms as a result of change in the way they are illuminated.

The **dark field microscope** is useful in revealing many internal structures in larger eukaryotic microorganisms.

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___ is also used in the examination of unstained microorganisms suspended in fluids, e.g. wet mount and hanging drop preparation.

dark field microscope

___ type of microscope converts slight differences in refractive index and cell density into easily detected variations in light intensity and is used to view living cells.

The Phase-Contrast Microscope

___ microscope is very useful for studying microbial motility, determining the shape of living cells and detecting some bacterial components such as endospores and inclusion bodies.

The Phase-Contrast Microscope

___ is also used in studying eukaryotes.

The Phase-Contrast Microscope

___ type of microscope exposes a specimen to ultraviolet, violet or blue light and forms an image of the object with resulting fluorescent light.

The Fluorescent Microscope

The most commonly used fluorescence microscope light is ___ microscope which is also called incident light or reflected light microscope.

epifluorescence

Epifluorescence microscope employs an objective lens that also acts as a condenser.

The ___ light is directed down the microscope by a speed minor called the dichromatic minor

Excitation

___ is the ability of a lens to separate or distinguish between small objects that are close together, i.e. the microscope must produce a clear image and not just a magnified one.

Resolution

___ is also known as the **resolving power**

Resolution

Resolution is described mathematically by an equation in the 1870s by Ernest Abbe, a German physicist.

The Abbe equation states that ___

the minimal distance (d) between two objects that reveal them as separate) used to illuminate the entities depends on the wavelength of light (λ) which is the specimen and on the numerical aperture of the lens (nsin ability of the lens to gather light.

the greatest resolution is obtained using a lens with the largest NA and light with the **shortest wavelength**.

There are **two** general methods used for preparing specimens for light microscope examination.

- i **The organisms are suspended in a liquid (the wet-mount or the hanging drop technique), and**
- ii **The organism is dried fixed and stained before observing under the microscope.**

___ technique permits examination of organisms in a normal living condition

The wet mount or hanging drop technique

A ___ is made by placing a drop of fluid containing the organisms on a glass slide and covering the drop with a cover slip.

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wet mount

___ are frequently used for the observation of the morphological characteristics of bacteria.

Fixed, Stained Smears of Microorganisms

___ is the process by which the internal and external structures of cells and microorganisms are preserved and fixed in position

Fixation

___ inactivates enzymes that might disrupt cell morphology and tough cell structures so that they do not change during staining and observation

Fixation

There are two fundamentally different types of fixation which are___

- **Heat Fixation**
- **Chemical Fixation**

Heat Fixation Is routinely used to observe prokaryotes.

Chemical Fixation Is used to protect fine cellular sub-structure and the morphology of larger, more delicate microorganisms.

Chemical fixatives penetrate cells and react with cellular components, usually proteins and lipids, to render them inactive, insoluble, and immobile

The Types of Staining includes___

- **Simple staining**
- **Differential staining**
- **Gram staining**

___ is a kind of staining in which a single stain or dye is used.

Simple staining

Differential staining are staining procedures that make visible the differences between bacterial cells or part of a bacterial cell

The Gram stain was developed in **1884** by the Danish physician ___

Christian Gram

___ is the most widely used differential staining procedure

Gram staining

Acid fast staining is another differential staining procedure commonly used to identify *Mycobacterium tuberculosis* and *Mycobacterium leprae*

In the acid fast staining procedure, the red stain and carbol fuchsin is used as **primary stain**; next acid-alcohol is used as a **decolouriser**

___ type of microscope uses a beam of electron in place of light waves to produce the image

Electron Microscope

There are two types of electron microscope which are___

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- scanning electron microscope
- transmission electron microscope.

Electron microscopes use a beam of electrons to illuminate and create magnified images of specimens.

___ is the chemical transformation of organic compounds carried out by microorganisms and their enzymes

Fermentation

In **industrial fermentation**, raw materials (substrate) are converted by microorganisms in a controlled favourable environment (created in a fermentor) to form a desired end product substance.

___ are used to produce fermented dairy products such as cheese, yoghurt and acidophilus milk.

Microorganism

___ are also used to produce alcoholic beverages such as beer by conversion of sugar to alcohol and carbon dioxide.

Fermentation

Pickles and some sausages are also produced by ___ processes.

fermentation

Wine fermented from fruits using yeast strains *Saccharomyces cerevisiae* and bread is also produced by using **yeasts**.

Microorganisms can also be used as direct source of food known as **single cell protein**.

___ are microbially produced substances or substances synthetically derived from natural sources that inhibit or kill microorganisms

Antibiotics

Steroids regulate various aspects of human metabolisms and are produced by organisms such *Rhizopus nigricans*

Vaccines are produced using microorganisms with the antigenic properties to elicit a primary immune response

___ are used to prevent many once deadly diseases such as polio, small pox, tuberculosis, measles, diphtheria and whooping cough.

Vaccines

Human insulin and human growth hormone are produced by ___ bacteria.

genetically engineered

Riboflavin produced by various species of *Clostridium* and *Ashbya gossypii*.

Gluconic acid used as a pharmaceutical to supply calcium to the body by several fungi including *Penicillium* and *Aspergillus* species.

Citric acid produced by ***Aspergillus niger***

___ used as a food additive especially in the production of soft drinks.

Citric acid

Gibberellic acid is a plant hormone is formed by the **fungus**.

Gibberella fujikuroi is used as growth promoting substances to stimulate plant growth flowering and seed germination

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___ is the avoidance of infection and food spoilage by eliminating microorganisms from the surrounding.

Hygiene

Microorganisms from the surroundings can be totally removed by methods such as sterilization or reduced to acceptable levels using methods such as disinfection and antiseptics

In food preparation, ___ are reduced to acceptable levels using methods such as pasteurization, addition of vinegar

Microbes

___ are used in fermentation to produce ethanol and in biogas reactions to produce methane using various forms of agricultural and urban wastes.

Microbes

The bacteria *Zymomonas mobilis* and *Thermoanaerobacter ethanolicus* and different yeast strains are used for product of ___

ethanol.

Methane (natural gas) is produced by methanogenic bacteria is another important natural renewable energy sources.

Methane can be used for the generation of mechanical, electrical and heat energy

Microbes are essential tools in biotechnology, biochemistry, genetics molecular biology and genomics.

Biotechnology uses genetic engineering which is the artificial manipulation of genes and gene products

human insulin, a hormone which is very low in people with diabetes is produced by **genetically engineered** bacteria into which human genes have been inserted.

Microorganisms are used to recover metals from their ores by the process of bioleaching

Bioleaching uses microorganisms to alter the physical or chemical properties of a metallic ore so that the metal can be extracted.

In terrestrial habitats, the microbial fixation of atmospheric nitrogen is carried out by free living bacteria such as **Rhizobium and Bradyrhizobium** living in symbiotic association with plants.

Legumes live in close association with bacteria that form structures called nodules on their roots.

AIDS (Acquired Immune Deficiency Syndrome) caused by the ___

Human Immuno Deficiency Virus (HIV).

Tuberculosis caused by a bacterium called ___

Mycobacterium tuberculosis.

Cholera caused by a bacteria called ___

Vibrio cholera.

Malaria caused by four species of the Protozoa called **Plasmodium** transmitted by the female anopheles mosquito.

Biological warfare is also known as **germ warfare**

___ is the use of pathogens such as viruses, bacteria, or the toxins produced by them as biological weapons or agents of warfare.

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Biological warfare

There are **four** kinds of biological warfare agents which are **_____**
bacteria, viruses, fungi and rickettsiae

_____ do not reproduce in the victims but within a short incubation period (usually with a few hours) kill the victims.

Toxins

Bacteria are characterised based on the **_____**
cell shape, size and structure cell arrangement, occurrence of special structures and developmental forms, staining reactions and motility and flagella arrangement

The General characteristics of bacteria are **_____**

- **They are prokaryotic**
- **They are simplest of all microbial cells**
- **Bacteria are single celled organisms**
- **They have distinctive cell wall which contain peptidoglycan**
- **They are measured in unit called micrometer**
- **Bacteria lack a true nucleus but have a region called the nucleoid region, i.e. DNA is free floating**
- **They may have additional DNA called a plasmid**
- **Their reproduction is by binary fission**
- **They are extremely diverse and numerous in soils and waters.**

Bacteria are very small, **0.5 to 1.0µm** in diameter

Examinations of a microbial cell require the use of a high power microscope usually of about **1,000** diameters.

The shape of a bacterium is governed by its **_____** cell wall which gives it a definite shape.

Rigid

The Typical shapes of bacteria are:

- **Cocci (Singular: Coccus), e.g. Staphylococcus**
- **Bacilli (rods) (Singular: rod, bacillus), e.g. Bacillus subtilis**
- **Vibrios (Singular: Vibrio)**
- **Spirilla (Singular: Sprillum)**
- **Spirochaetes (Singular: Spirochaete), e.g. Treponema pallidum**

Some species of bacteria are pleomorphic, i.e. **_____**

they are able to change their forms especially when grown on artificial media.

_____ are round, oval or spherical in diameter characteristic arrangement when multiplying is based on arrangement of cell

Cocci

cocci in **pairs** are called **_____**

Diplococci

_____ cocci in **chains**

Streptococci

Staphylococci are cocci in irregular clusters (like a bunch of grapes)

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Tetrads are cocci in a group of **four** cells.

Sarcinae are cocci in **regular clusters**.

Bacilli (Rod) are stick like bacteria with rounded, square, tapered or swollen ends

Diplobacilli are Rods in **pairs**

Streptobacilli are Rods **in chains**.

Trichomes are Similar to chains but have larger area of contact between adjacent cells Mass together, e.g. Mycobacterium leprae

Palisade arrangement cells are lined side by side like matchsticks and at angles to each other like Chinese letters, e.g. Corynebacterium diphtheriae.

Vibrios are small slightly curved rods, or comma shaped **3- 4µm** in length by **0.5µm** in width.

Spirilla are helical bacteria, small, regularly coiled, rigid, organisms measuring **3-4µm** in length.

Spirochaetes are helical, (complete twist), flexible, coiled organisms, can twist and contort their shapes.

Spirochaetes are divided into three main groups which are ____

- **Treponemes**
- **Borreliae**
- **Leptospirae**

The shape of a cell affects its **survival and activity** in the environment.

Based on their location on the cell, flagella may be **polar or lateral**.

A flagellum is composed of **three** parts:

- **i A basal body associated with the cytoplasmic, membrane and cell wall.**
- **ii A short hook and a helical filament which is usually several times as long as the cell.**
- **iii A flagellum grows at the tip rather than at the base.**

The Types of Flagella are ____

- **Monotrichous**
- **Lophotrichous**
- **Amphitrichous**
- **Peritrichous**

A single polar flagellum is called **Monotrichous**

A cluster of polar flagella is called ____

Lophotrichous

Flagella, either single or clusters at both cell poles is called **Amphitrichous**

Pili (Singular: Pilus) are also called **fimbriae**

___ are hollow, non-helical filamentous appendages that are thinner, shorter and more numerous than flagella: long, thin, straight threads 3-25µm in diameter and 12µm in length

Pili

F pilus (Sex pilus) serves as the path of entry of genetic material during bacterial mating

Capsules is a viscous substance forming a covering layer or envelope around the cell wall of some bacteria

most bacterial capsules consist of polysaccharides which can be **homopolysaccharides** or **heteropolysaccharides**

Capsule made up of/composed of a single kind of sugar usually synthesized outside the cell by exocellular enzymes, e.g. glucan (a polymer of glucose) from sucrose by *S. mutans* are called ___

Homopolysaccharides

Heteropolysaccharides are Composed of several kinds of sugars

Some bacterial species form chains or trichomes enclosed by a hollow tube called **sheaths**

___ are semi rigid extensions of the cell wall and cytoplasmic membrane and have a diameter less than that of the cell

Prosthecae

Stalks are non-living ribbon -like or tubular appendages excreted by some bacterial cells, e.g. found in *Gallionella* or *Planctomyces*.

___ is a very rigid structure that gives shape to the cells

The Cell Wall

___ also prevents the cell from expanding and eventually bursting of uptake of water since most bacteria live in hypotonic environment

Cell wall

Cell walls are essential for bacterial growth and division.

The cell wall of bacteria is made up of **peptidoglycan** (sometimes called Murein).

Peptidoglycan is found only in prokaryotes

Bacteria are classified based on differences in the composition of **cell wall**

The Gram stain is named after **Christian Gram**, a Danish physician who invented it in **1884**.

Gram positive bacteria stained **purple** whereas Gram negative bacteria stain **pink or red** by the Gram stain technique.

A ___ is the portion of a bacterial, all made up of the cytoplasmic membrane and the cell material bounded by it.

Protoplast

___ is the cell material bounded by the cytoplasmic membrane

The Cytoplasm

Unlike cells, bacterial cells do not have a distinct membrane enclosed nucleus

Eukaryotic

The ___ is circular and bears the genes of the cell.

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DNA

Endospores are spores within the cells

exospores are spores external to the cell

The **spore** is metabolically dormant form which under appropriate condition can germinate to form a vegetative cell.

Endospores are extremely resistant to desiccation, staining, disinfecting chemicals, radiation and heat.

Cysts are also dormant, thick walled desiccation resistant forms that can germinate also under favourable conditioning

The nutrition requirements of bacteria vary widely, Based on their source of energy, they are classified as:

- **Phototrophs**
- **Chemotrophs**

___ are bacteria that use light energy as their energy sources

Phototrophs

Chemotrophs obtain their energy by oxidizing inorganic or organic – chemical compounds.

The nutrition requirements of bacteria vary widely, Based on the source of carbon which is the major source of nutrient for all cells bacteria can be classified as:

- **Heterotrophs**
- **Autotrophs**

Heterotrophs bacteria are bacteria that derive carbon from preformed organic nutrients such as sugar or carbohydrate

Autotrophs bacteria derive carbon from inorganic sources such as carbon dioxide.

The nutrition requirements of bacteria vary widely. Based on whether they need oxygen to survive or not, bacteria may be:

- **aerobic or strict aerobe**
- **anaerobic bacteria or strict anaerobes**
- **facultative anaerobes**

aerobic or strict aerobes bacteria require oxygen, e.g. *Bacillus cereus*.

anaerobic bacteria or strict anaerobes cannot tolerate oxygen, e.g. *Clostridium* spp

facultative anaerobes are generally aerobes but have the capacity to grow in the absence of oxygen, e.g. *Staphylococcus* spp

Bacteria reproduce mainly by asexual method which most of the time is **transverse binary fission**

___ is a process in which a bacterial cell divides to give two daughter cells after developing a transverse septum (cross wall).

Binary fission

A ___ is a viscous substance forming a covers layer or envelope around the cell wall of some bacteria.
capsule

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Capsules act as protection against drying, bacteriophages and engulfment of pathogenic bacteria by white blood cells.

_____ are eukaryotic spore bearing organisms that lack chlorophyll and generally reproduce both sexually and asexually
Fungi

Fungi comprise the molds, mushrooms and yeasts.

Molds are filamentous and multicellular while yeasts are unicellular.

The Distinguishing Characteristics of Fungi are _____

1. **Fungi are Eucaryotic. They are members of the domain Eucarya.**
2. **They contain a membrane-enclosed nucleus and several other organelles.**
3. **They have no chlorophyll.**
4. **They are chemo organotrophic organisms.**
5. **The body of the fungi is called thallus.**
6. **The thallus may consist of a single cell as found in yeasts.**
7. **The thallus may consist of filaments, 5 to 10µm across which are commonly branched as found in molds.**
8. **The yeast cell or mold filament is surrounded by a true cell wall (exception is the slime mould which have a thallus consisting of a naked amoeboid mass of protoplasm).**
9. **Some fungi are dimorphic, that is they exist in two forms.**
10. **Habitat distribution of fungi is diverse. Some are aquatic, living primarily in fresh water and a few marine fungi are terrestrial.**

The study of fungi is known as _____

Mycology

The fungal cell is usually enclosed in a cell wall of **chitin**.

The characteristics of yeast are _____

- **They are unicellular fungi that have a single nucleus.**
- **They are commonly egg-shaped but some are elongated and some spherical.**
- **They possess most of the other eukaryotic organelles.**
- **Yeast cells are larger than most bacteria. Yeasts vary considerably in size ranging from 1 to 5µm in width and from 5 to 30µm or more in length.**
- **They reproduce asexually by budding and traverse division or sexually through spore formation.**

The thallus of a mold consists of long branched threadlike filaments of cells called _____
hyphae

Hyphae are composed of an outer tube like wall surrounding a cavity the Lumen which is filled or lined by protoplasm

The **mycelium** is a complex of several filaments called hyphae (singular, hypha).

In some fungi, protoplasm streams through hyphae uninterrupted by cross walls, these hyphae are called _____
coenocytic or aseptate

The Nutrition and Metabolism of fungi are _____

- **Most fungi are saprobes, securing their nutrients from dead organic matters.**
- **They are also chemoorganoheterotrophs, i.e. they use organic compounds as a source of carbon, electrons and energy.**

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- **Fungi are usually aerobic; however, some yeasts are facultatively anaerobic and can obtain their energy by fermentation.**

Asexual reproduction is a type of reproduction involving only one parent that produces genetically identical offspring by budding or by the division of a single cell or the entire organism into two or more parts

Asexual reproduction also called **somatic or vegetative reproduction**

Sporangiospores are single-celled spores formed within sacs called sporangia (singular: sporangium) at the end of special hyphae called sporangiospores).

There are **two** types of sporangiospores which are__

Aplanospores and zoospores

Conidiospores or conidia (singular, conidium). are formed at the **tip or side** of a hypha

Single celled conidia are called __

Microconidia

large multicelled conidia are called__

macroconidia.

Oidia (singular oidium) or arthrosopores are singlecelled spores formed by disjoining of hyphal cells.

Chlamydospores are thick walled single celled spores which are highly resistant to adverse conditions.

Blastospores are spores formed by budding.

Sexual reproduction is a type of reproduction in which two parents give rise to offspring that have unique combinations of genes inherited from the gametes of the two parents.

__ is carried out by fusion of the compatible nuclei of two parent cells

sexual reproduction

the fusion of protoplast is called__

plasmogamy

the two haploid nuclei of two mating types to fuse together is called ____

(karyogamy)

The sex organelles of fungi if present are called **gametangia**

If the male and female gametangia are morphologically different, the male gametangium is called the antheridium

the female gametangium is called the ____

Oogonium

the Methods of sexual reproduction include__

- **Gametic copulation**
- **Gamete-gametangial copulation**
- **Gametangial copulation**
- **Somatic copulation**
- **Spermatization**

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Gametic copulation is the fusion of naked gametes, one or both of which are motile

Two gametangia came into contact but do not fuse; the male nucleus migrate through a pore or fertilization to be into the female gametangium is referred to as **Gamete-gametangial copulation**

Two gametangia or their protoplast fuse and give rise to a zygote that develops into a resting spore is referred to as **Gametangial copulation**

Fusion of somatic or vegetative cells is called **Somatic copulation**

Union of a special male structure called a spermatium (plural spermatia) with a female receptive structure is called **Spermatization**

Sexual spores are produced by the fusion of two nuclei.

Examples of Sexual spores ____

- **Ascospores**
- **Basidiospore**
- **Zygosporos**

Ascospores are single-celled spores produced in a sac called an ascus

There are usually **eight** ascospores in each ascus

Basidiospore are single celled spores borne on a clubshaped structure called a basidium

Zygosporos are large thick walled spores formed when the tips of two sexually compatible hyphae or gametangia fuse together

Oospores are formed with a special female structure, the oogonium.

Fertilization of the eggs or oospheres by the male gametes formed in an **antheridium** give rise to oospores

The optimum temperature for most saprobic species is **22 to 30°C**

The optimum temperature for most pathogenic fungi have a higher temperature optimum of **30 to 37°C**.

About ____ fungal species have been described according to literature.

90,000

Beneficially, fungi act as **decomposers**

Moulds and yeasts are used in many industrial processes involving fermentation to produce beer, wine and bread, cheese soy-sauce, organic acids and many antibiotics

Asexual reproduction occurs in fungi by the production of specific types of spores which are easily **dispersed**.

Sexual reproduction occurs by the **fusion of hyphae** or cells of different mating types.

Viruses are ____ entities

Acellular

____ are genetic elements that cannot replicate independently of a living cell called the host cell

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Virus

Viruses have extracellular forms which enable them to exist outside the host for long periods

Viruses are the most numerous microorganisms on earth and infect all types of cellular organisms

The study of viruses is known as _
virology

Viruses are simple acellular entities that can only reproduce within living cells

The General Characteristics of Viruses are__

- **They are the smallest microorganisms**
- **They are acellular, i.e. not cellular and non living.**
- **They only reproduce when present within living cells.**
- **They are infectious agents.**
- **A complex virus particle or virion consists of one or more molecules of DNA or RNA enclosed in a coat of protein.**
- **Viruses can exist in two phases: extracellular and intracellular.**
- **The extracellular phase known as virion possesses few if any enzymes and cannot reproduce independent of living cells**
- **In the intracellular phase, viruses exist primarily as replicating nucleic acids in the host cells that induce host metabolism to synthesise virion components which are later released.**

Virus range in size from m in diameter and can only be viewed under an **10 to 400** electronmicroscope

Viruses differ from living cells in **three** ways:

- **They have simple acellular organisation.**
- **The presence of either DNA or RNA but not both in almost all virions.**
- **They do not have the ability to reproduce independent of cells and carry out cell division as procaryotes and eukaryotes do**

Virions range in size from about **10 to 400µm** in diameter.

A virus is made up of a central genetic nucleic acid molecule surrounded by a protein coat called a **capsid**

The combination of genetic nucleic acid and capsid is called ____
nucleocapsid

The **capsid** surrounds and protects the viral nucleic acid.

Capsids are large macromolecular structures that self assemble from many copies of one or a few types of proteins
The protein used to build the capsids is called protomers.

The **simplest virus** is a naked virus (nucleocapsid) consisting of a geometric capsid assembled around a nucleic acid
a virus made up of a nucleocapsid surrounded by a flexible membrane called an envelope. This type of virus is called an ____
envelope virus.

All cells contain **double** stranded DNA genomes

There are **three** types of capsid symmetry: helical, icosahedral and complex

Helical Capsids are shaped like hollow tubes with protein walls.

tobacco mosaic virus is an example of Helical Capsids virus

the first step in the life cycle of a virus is attached to a ___
host.

the steps involved in viral replication or reproduction are:

- **attachment of the virion to a susceptible host**
- **penetration or entry of the virion or its nucleic acid into the host**
- **synthesis of virus nucleic acid and protein by cell metabolism as directed by the virus**
- **assembly of capsids and packaging of viral genomes into new virions**
- **release of mature virions from the cell.**

Animal viruses are cultivated by inoculating suitable host animals or embryonated egg – fertilised chicken eggs incubated about **6 to 8 days** after laying

Plant viruses are cultivated in a variety of ways which include plant tissue cultures, cultures of separated cells, or cultures of protoplasts (cells lacking cell wall) and growing of the viruses in whole plants

Virus Purification involves getting or isolating the viral particle in its pure state, purification makes use of several virus properties

The **Four** of the most widely used methods to isolate and purify viruses are:

- **differential and density gradient centrifugation. This is often used in the initial purification steps to separate virus particles from host cells.**
- **precipitation of viruses particles.**
- **denaturation of contaminants.**
- **enzymatic digestion of host cells constituents**

the singular of Algae is called ___
alga

Algae are heterogeneous and range from microscopic unicellular forms to macroscopic seaweeds

The General Characteristics of Algae are__

- **Algae are eukaryotic microorganisms.**
- **They are photosynthetic microorganisms.**
- **Chlorophyll and other pigments are found in membrane bound organelles known as chloroplasts.**
- **They have a wide range of sizes and shapes. Many species occur as single cells that may be spherical, rod shaped, club-shaped or spindle-shaped. Others are multicellular and appear in every conceivable form, shape and degree of complexity.**
- **In most species the cell wall is thin and rigid cell walls of diatoms are impregnated with silica making them thick and very rigid.**
- **The motile algae such as euglena have flexible cell membrane called periplasts.**
- **They are also able to produce oxygen from water.**

___ occur in great abundance in the ocean, seas, salt lakes, fresh water lakes ponds and streams.
Algae

Algae are found where there are sufficient light, moisture and simple nutrients to sustain them

The motile algae also called the **swimming algae**

Asexual reproduction processes in algae include:

- **purely vegetative binary fission.**
- **production of unicellular spores, many of which, especially in the aquatic forms have flagella and are motile, these are called zoospores.**

If the gametes are identical, i.e., there is no visible sex differentiation. The fusion process is called **isogamous**

The type of sexual reproduction in algae is called **oogamy**

The Biological and Economic Importance of Algae are__

- **Algae as Primary Producers**
- **Commercial Product from Algae**
- **Algae as Food**

Protozoa are unicellular, non-photosynthetic eukaryotic organisms

__ are distinguished from other eukaryotic protists by their ability to move at some stage of their life cycle and by their lack of cell walls

Protozoa

The study of protozoa is called__
Protozoology

The General Characteristics of Protozoa

- **They are unicellular, non-photosynthetic microorganisms.**
- **They are predominantly microscopic in size.**
- **They occur generally as single cells.**
- **They lack cell walls.**
- **They have ability to move at some stages of their life cycle. Many are motile.**
- **The majority of protozoa are between 5 and 250µm in diameter.**
- **They occur in colonies with each colony having independent individual cells. Protozoa may be divided into free-living forms and those living on or in other organisms.**
- **protozoa may be divided into free-living forms and those living on or in other organisms**

Symbiotic Protozoa is a type of co-existence between protozoa and other organisms which differ in many way

Commensalism is which the host is neither injured nor benefitted but the commensal (protozoa) is benefitted, e.g. the protozoa living in the lumen of the alimentary tract

Mutualism is which some flagellates are present in the gut of termites and help to digest the woody materials eaten by termite to a form which can be used by the host cells

Submicroscopic protein fibrils (fibrillar bundles, myonemes, and microtubules) are groups of parallel fibrils in the cytoplasm.

Cysts have **four** basic functions:

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- **protect against unfavourable conditions**
- **serve as site of multiplication**
- **assist in attachment to surfaces such as hosts**
- **transmission stage from host to host**

Protozoa may move by **three** types of specialised organelles which are **pseudopodia, flagella and cilia**

A **_____** is a temporary projection of part of the cytoplasm of those protozoa which do not have a rigid pellicle. Pseudopodia are therefore characteristic of the amoebas (sarcodina).

Pseudopodium

The **flagellum** is an extremely fine filamentous extension of the cell

A **flagellum** is composed of two parts; an elastic filament called an axoneme and the contractile cytoplasmic sheath that surrounds the axoneme.

Amoebas gather food by means of **pseudopodial engulfment**

An **oral groove** is an indentation in the pellicle of certain ciliates.

The nutrition of protozoa are **_____**

- **Nutrition in protozoa is heterotrophic.**
- **They obtain cellular energy from organic substances such as proteins.**
- **Protozoa engulf and ingest their food sources.**

Asexual reproduction occurs by simple cell division, which can be equal or unequal – the daughter cells are of equal or unequal sizes, respectively.

If two daughter cells are formed, then the process is called **binary fission**

If many daughter cells are formed, it is called **multiple fission**

Budding is a variation of unequal cell division.

Binary Fission is The simplest form of binary fission is found in the amoebas.

In **_____** fission, a single mother (parental) cell divides to form many daughter (filial) cells.

Multiple

In protozoology, **_____** is often used to describe the varied processes by which sessile protozoa produce motile offspring.

Budding

Conjugation is generally a temporary union of two individuals for the purpose of exchanging nuclear material, is a sexual process found exclusively in the ciliates.

When the gametes (which develop from trophozoites) are morphologically alike, they are called **isogametes**.

The Economic Importance of Protozoa are **_____**

- **Protozoa are important links in the food chain of communities in**

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- aquatic environment where they act as primary consumers.
- They are used in biological treatment of sewage or industrial effluents.
- Some protozoa cause disease in mammals including man.
- They are important research organisms for biologists and chemists

Microbial growth is defined as an increase in the number of cells

___ is the ultimate process in the life of a cell – one cell becoming two and subsequently leading to an increase in the number in a population of microorganisms.

Growth

___ is defined as an increase in the number of cells in a population of microorganisms

Growth

___ is an increase in cellular constituents leading to a rise in cell number when microorganisms reproduce by processes like binary fission or budding.

Growth

Binary fission is a form of asexual reproduction process. In which a single cell divides into two cells after developing a transverse septum (crosswall).

Binary fission is a simple type of cell division and the processes involved are: the cell elongates, replicates its chromosomes and separates the newly formed DNA molecules so that there is a chromosome in each half of the cell

___ is the process of forming a crosswall between two daughter cells

Septation

a term that has traditionally been used to describe the formation of two eukaryotic daughter cells, is used to describe the process in procaryotes as well is referred to as **Cytokinesis**

The Septation is divided into several steps:

- Selection of site where the septum will be formed.
- Assembly of a specialised structure called the Z ring, which divides the cell in two by constriction.
- Linkages of the Z ring to the plasma membrane and perhaps components of the cell walls.
- Assembly of the cell wall-synthesizing machinery.
- Construction of the Z ring and septum formation

___ is a curve that describes the entire growth cycle of a microorganism.

The Growth Curve

___ is the growth of microorganism reproducing by binary fission, plotted as the logarithm of the number of viable cells versus the incubation time.

The growth curve

The growth curve has four phases___

the lag phase, the exponential phase, the stationary phase and the death phase.

___ is a phase in which there is no increase in the cell number of a microbial population freshly introduced into a fresh culture medium

Lag Phase

Lag phase before cell division begins may be necessary for these reasons:

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- i The cell may be old and depleted of ATP, essential cofactors and ribosome which the cell synthesises at this phase or stage.
- ii The new medium may be different from the one the microorganism was growing in previously; the cells synthesise
- new enzymes to be used in the new medium.
- iii The cell is acclimatising to a new environment.
- iv The cells may be injured and require time to recover.

Exponential Phase is also known as the **log phase**

___ is a period in which the microorganisms are growing and dividing at the maximal rate possible given their genetic potential, the nature of the medium and the conditions under which they are growing

Exponential Phase

___ is during this period that the generation time of the organism is determined.

Exponential Phase

The **exponential growth** is balanced growth this is because cellular constituents are manufactured at constant rates relative to each other.

The shift up occurs when a ___

culture of microorganism is transferred from a nutritionally poor medium to a richer one while the shift down occurs when a culture of microorganism is transferred from a rich medium to a poor one

___ is a phase in which population growth ceases and the growth curve becomes horizontal.

The Stationary Phase

The Factors responsible for stationary phase when a required nutrient is exhausted are:

- **Nutrient limitation**
- **Accumulation of toxic waste products**
- **When a critical population level has been reached**

___ is a phase in which the number of viable cells begins to decline. During this phase, the number of living cells decreases because the rate of cell death exceeds the rate of new cell formation

Death Phase

A continuous culture is an ___ culture

open

there are Two major types of continuous culture system commonly used are___

i chemostats and

ii turbidostats.

A **chemostat** is a device in which a liquid medium is continuously fed into the bacteria culture.

___ is an apparatus designed to permit the growth of bacterial cultures at controlled rates.

Chemostat

A **chemostat** is constructed so that sterile medium is fed into the culture vessel at the same rate as the spent media containing microorganisms is removed.

Microorganisms can be grown in an **open system** in which nutrients are constantly provided and wastes removed

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Population growth is measured by following changes in cell number and cell mass; this is because growth leads to increase in both.

The total number of microbial cells can be achieved by using **direct count methods**.

Bacteria, microorganisms can be enumerated by direct counting procedure using:

- **i Special counting chambers such as hemocytometer and Petroffitausser chamber can be employed to determine the number of bacteria**
- **ii. Large microorganisms such as protists and yeast can be directly counted using electronic chambers such as the coulter counter and the flow cytometer**
- **iii. The Membrane Filter Technique**

Viable Counting Methods are methods involving plating serial dilutions of a suspension of microorganisms onto a suitable solid growth medium and after a period of incubation (in which single cells multiply to form visible colonies) the number of colonies are counted or enumerated.

There are **Two** commonly used methods of viable counting methods are the **spread plate technique and the pour plate technique**

The Advantages of Viable Counts Methods or Plating Techniques are__

- **They are simple technique sensitive.**
- **Widely used for viable counts of bacteria and other microorganisms in samples of food, water and soil.**

The Disadvantages or Limitation of Viable Counts Methods or Plating Techniques are__

- **It is selective.**
- **The nature of the growth medium and the incubation condition determine which bacteria can be grown and counted.**
- **Sometimes, cells are viable but not culturable.**

The **point of extinction** is the dilution level at which no single cell is deposited into one or more multiple tubes.

The Techniques for measuring changes in cell mass can be used to measure growth of microorganisms. They include__

- **Determination of Microbial Dry Weight**
- **Spectrophotometry**

Cells growing in liquid medium are collected by centrifugation, washed, dried in an oven and weighed.

___ is a useful technique for measuring growth of filamentous fungi;

Microbial Dry Weight

___ method depends on the fact that microbial cells scatter light that strikes them because microbial cells in a population are of roughly constant size; the amount of scattering is directly proportioned to the biomass of cell present and indirectly related to cell number.

Spectrophotometry

The Factors Influencing Microbial Growth are__

- **The rate of microbial growth and death are greatly influenced by environmental factors or parameters.**
- **Some environmental conditions favour rapid microbial growth while others do not permit bacterial reproduction.**
- **Understanding the influence of environmental factors on microorganisms helps in the control of microbial growth and the study of ecological distribution of microorganisms.**

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- These factors include: temperature, solute, and water activity, pH, oxygen level, pressure, radiation.

Temperature is the most important factor affecting the growth and survival of microorganism

Microorganisms can be placed in five classes based on their temperature for growth:

- **Psychrophiles**
- **Psychrotrophs or Facultative Psychrophiles**
- **Mesophiles**
- **Thermophiles**
- **Extreme Thermophiles or Hyperthermophiles**

Extreme Thermophiles or Hyperthermophiles are prokaryotes that have growth optima between **80°C and 113°C**.

Pyrococcus abyss and **Pyrodictum** are example of marine hyperthermophiles

Thermophiles are microorganisms can grow at temperature of **55°C or higher**

Mesophiles are microorganism with growth optima around **20°C to 45°C**.

Psychrotrophs or Facultative Psychrophiles are organisms can grow at **0°C to 7°C** even though they have optima between **20°C and 30°C** and maxima at about **35°C**

Psychrophiles are organisms that grow well at **0°C** and have an optimum growth temperature of **15°C or lower**.

Based on the ability to grow in the presence or absent of oxygen. Microorganisms are classified as:

- **Aerobes**
- **Anerobic**
- **Facultative**
- **Aerotolrant Anaerobe**
- **Strick or Obligate Anaerobe**
- **Microaerophile**

___are organism that able to grow in the presence of atmospheric oxygen

Aerobes

___ organism grow in the absence of atmospheric oxygen

Anerobic

Facultative are organism that do not require oxygen for growth but grow better in its presence

Aerotolrant Anaerobe are not dependent on oxygen. They grow equal whether oxygen is present or absence

Strick or Obligate Anaerobe do not tolerate oxygen at all and due to its presence

Microaerophile are organisms are damaged by normal atmospheric level of oxygen (20%) and require O₂ level below the range of 2 to 10% for growth

___ is a measure of the hydrogen ion activity of a solution and is defined as the negative logarithms of the hydrogen concentration

pH

The pH scale extends from pH 0.0 to pH 14 and each pH unit represents a tenfold change in hydrogen ion concentration

Based on pH growth range and pH growth optimum we have the following group of organisms.

- i **Acidophiles**
- ii **Neutrophiles**
- iii **Alkalophiles**

Acidophiles have their growth optimum between pH 0 and 5.5.

Neutrophiles have their Growth optimum between 5.5 and 8.0.

Alkalophiles have their Growth optimum between 8.0 and 11.5

Extreme alkalophiles have growth optima at pH 10 or higher

Most bacteria and protists are **neutrophiles**.

Most fungi are acidophiles have pH between 4 and 6

Many archaea are **acidophiles**.

Photosynthetic protist also favours slight acidity.

___ - is the ability of a microorganism to grow over a wide range of water activity or osmotic concentration.

Solute and Water Activity

Selectively permeable plasma membrane separates microorganisms from their environment

if a **microorganism** is placed in hypertonic solution (one with a higher osmotic concentration) water will flow out of the cell

In microbes that have cell walls (i.e. most prokaryotes, fungi and algae), the membrane shrinks away from the cell wall - a process called ___
plasmolysis.

Organisms able to live in environments high in sugar as a solute are called ___
Osmophiles

Organisms able to grow in very dry environments (made dry by lack of water rather than by dissolved solute) are called ___
xerophiles.

Sunlight is the major source of radiation on the earth.

The Two major forms of ionizing radiation are:

- i **X-rays, which are artificially produced, and**
- ii **Gamma rays which are emitted during radioisotope decay**

Sterilisation is the process by which all living cells, spores and acellular entities (e.g.) viruses, viroids and prions) are either destroyed or removed from an object or habitat.

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___ can also be defined as the killing or removal of all viable organisms within a growth medium

Sterilisation

Microbial population death is exponential or logarithmic, meaning the population will be reduced by the same fraction at constant interval

The most common sterilisation method used for controlling and destroying microbial growth is the use of **heat**.

Heat can kill microorganisms by denaturing the enzymes which prevent them from multiplying.

Factors that determine the effectiveness of heat sterilization include the___
temperature and duration of the heat treatment, and whether the heat is moist or dry

Viability is lost because at very high temperatures most macromolecules lose structure and function, a process called denaturation

The **autoclave** is a sealed heating device that allows the entrance of steam under pressure

Dry Heat Sterilisation is a method of heat sterilisation in which the objects or materials are sterilised in the absence of water.

Filtration is a method that accomplishes decontamination and even sterilization

___ This is made up of fibrous or granular materials that have been bonded into a thick layer filled with twisting channels of small diameters

Depth Filters

___ are used for the filter sterilisation of air in industrial processes

Depth filter

Membrane filters are the most common type of filters used for liquid sterilization in the microbiology laboratory.

Ionising radiation is a form of radiation which has very short wave length and high energy, which can cause atoms to lose electrons

There are **Two** major forms of ionising radiation;

- **X-rays (short wavelength of 10-3 to 10⁻² nanometers) which are artificially produced.**
- **Gamma rays (short wavelength of 10⁻³ to 10⁻¹ nanometer) which are emitted during radioisotope decay.**

Ultraviolet (UV) Radiation are radiation of short wavelength (from **10 to 400µm**) and high energy.

The most lethal UV radiation has a wavelength of **260µm**, the wavelength mostly absorbed by DNA
Radiation is currently used for sterilisation and decontamination in the medical supplies and food industries

Autoclaving involves using steam under pressure at a temperature of 121°C for 15 minutes.

Disinfection is the killing, inhibition or removal of organisms that may be capable of causing diseases

___ is the process of destroying infectious agents

Disinfection

Disinfectants are antimicrobial agents, usually chemicals, used to carry out disinfection

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An **antimicrobial agent** is a natural or synthetic chemical that kills or inhibits the growth of microorganisms

Agents that kill organisms are called **-cidal agents** Thus, they are called bactericidal, fungicidal and viricidal agents because they kill bacteria, fungi and viruses

Agents that do not kill but only inhibit growth are called **-static agents** thus they are These include bacteriostatic, fungistatic and viristatic compounds.

The Characteristics of an Ideal Antimicrobial Agent or Disinfectant are__

- . It should have a **broad spectrum of antimicrobial activity**
- ii. It must be active even at low concentration.
- iii. It must be active in the presence of organic matter.
- iv. Non-toxicity to human and other animals. It should be toxic to the infectious agent.
- v. It must be non-corroding and non-staining.
- vi. It must be stable upon storage.
- vii. Odourless or with pleasant smell.
- viii. It must be soluble in water and lipids for proper penetration of microorganisms.
- ix. It must be uniform in composition so that active ingredients are present in each application.
- x. It must have a low surface tension so as to penetrate cracks in surfaces.
- xi. It must be readily available.
- xii. It must be relatively inexpensive.

The Factors for the Selection of a Chemical Agent are__

- **The nature of the material to be treated**
- **Types of microorganisms**
- **Environmental condition**

The Major Groups of Chemical Antimicrobial Agents are__

- **Phenol and phenolic compounds**
- **Alcohols**
- **Halogens**
- **Heavy metals and their compounds**
- **Dyes**
- **Detergents**
- **Quaternary ammonium compounds**
- **Aldehydes**
- **Gaseous agents**

___ is also known as carbolic acid and is the oldest recognised disinfectant.

Phenol

Phenol is also known as **Carbolic acid**

___ was the first widely used antiseptic and disinfectant

Phenol

Two most popular alcohols germicides are **ethanol and isopropanol** usually used at 70 to 80% concentration

Isopropanol has the highest bactericidal activity and is the most widely used.

___ act by denaturing proteins and by dissolving membrane lipids and acting as a dehydrating agent

Isopropanol

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A **halogen** is any of the five elements in group VIIA of the periodic table

Chlorine is the usual disinfectant for municipal water supplies and swimming pools.

Quaternary Ammonium Compounds (Detergents) are detergents that have antimicrobial activity.

Detergents are organic cleaning agents that are amphipathic, having both polar hydrophilic and non-polar hydrophobic components.

___ act by disrupting microbial membrane and by denaturing proteins.

Detergents

Ethylene Oxide (EtO) is both microbicidal and sporicidal and kills by combining with cell proteins

Betapropiolactone (BPL) decomposes to an inactive form after several hours and is therefore not as difficult to eliminate as EtO

Vaporised Hydrogen Peroxide can be used to decontaminate biological safety cabinets, operating rooms and other large facilities

Ethylene oxide gas is use to sterilise heat sensitive materials like disposable plastic Petri dishes.

Carl von Linne or Carolus Linnaeus, as he is often called, developed the first natural classification based largely on anatomical characteristics in the middle of the eighteenth century.

many taxonomists define ___ in more general terms as "the scientific study of organisms with the ultimate objective of characterizing and arranging them in an orderly manner
systemic

___ is defined as the science of biological classification

Taxonomy

In a broader sense, ___ consists of three separate but interrelated parts: classification, nomenclature, and identification

Taxonomy

Classification is the organisation of organisms into progressively more inclusive groups on the basis of either phenotypic similarity or evolutionary relationship.

Nomenclature is the branch of taxonomy concerned with the assignment of giving names to taxonomic groups in agreement with published rules.

Identification is the practical side of taxonomy, the process of determining if a particular isolate belongs to a recognised taxon

___ is the scientific study of organisms with the ultimate objective of characterising and arranging them in an orderly manner.

Systematics

The polyphasic approach to taxonomy uses **three** kinds of methods___
phenotypic, genotypic and phylogenetic for the identification and description of bacteria.

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Phenotypic analysis examines the morphological, metabolic, physiological and chemical characteristics of the organisms

The Methods of Classification are____

- **Phenotypic classification**
- **Phylogenetic classification:**
- **Genotypic classification**
- **Numeric taxonomy**

Numeric taxonomy is grouping of taxonomic units into taxa on the basis of their character state by numerical methods

Genotypic classification Compares the genetic similarity between organisms' individual genes or whole genomes can be compared

Phylogenetic classification Compares organisms on the basis of evolutionary relationships

The term ____refers to the evolutionary development of species

Phylogeny

Phenotypic classification is the grouping of microorganisms together based on the mutual similarity of the phenotypic characteristics.

The basic taxonomic group in microbial taxonomy is the ____

Species

A **prokaryotic species** is a collection of strains that share many stable properties and differ significantly from other groups of strains

A **strain** consists of the descendants of a single, pure microbial culture

A **genus** is a well-defined group of one or more species that is clearly separate from other genera

A group of similar genera is called **Family**

A group of similar families is called **Order**

A group of similar orders is called **Class**

A group of similar classes **Phylum**

A group of similar phyla is called **Domain**

Microbiologists name microorganisms by using the **binomial system of Linnaeus**.

The most widely used reference for bacteria classification is____

Bergey's Manual of Systematic Bacteriology

Divisions within Bergey's manual are based on characteristics such as:

Gram, reaction, cell, shape, cell arrangement, oxygen requirements, motility, metabolic properties.

Bergey's Manual of Systematic Bacteriology, Volume 1 is made up of the ordinary Gram negative chemoheterotrophic bacteria. Many of which have clinical, industrial or agricultural importance. They include:

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- **The Spirochetes**
- **Aerobic/motile, Helical/Vibrioid Bacteria**
- **Non Motile Gram Negative Curved Bacteria**
- **Gram Negative, Aerobic Rods and Cocci**
- **Facultatively Anaerobic, Gram-Negative Rods**
- **Aerobic, Gram-Negative Rods**

__ - are found in anaerobic sediments; reduce oxidised forms of sulphur to H₂S

Dissimilatory Sulphate-Reducing or Sulfur - Reducing Bacteria

Anaerobic Non-filamentous or Filamentous organisms are either anaerobes or if facultatively anaerobic are preferentially anaerobic

Nocardioforms are aerobic bacteria that produce a substrate mycelium i.e. a mat of branching hyphae formed under the surface of the agar medium.

Anoxygenic Phototropic Bacteria belong to the order **Rhodospirillales**

__ are Gram-negative and capable of carrying out photolithotrophic or photoorganotrophic type of metabolism

Anoxygenic Phototropic Bacteria

Budding and/or Appendaged Bacteria are Gram-negative non-phototrophic bacteria that reproduce asymmetrically by budding and or form prostheca or stalks (Nonliving ribbon-like or tubular appendages that are excreted by the cell).

Examples of __ bacteria includes Hyphomicrobium, Alcalimicrobium, Caulobacter.

Budding and/or Appendaged Bacteria

The Three main categories of archaeobacteria recognised are the __
methanogens, the red extreme halophiles, and the thermo-acidophiles

Chytridiomycetes or chytrids are the earliest and the simplest group of fungi.

The Zygomycota are made of fungi called **Zygomycetes**

Ascomycota Members of this group are called Ascomycetes, commonly known as **sac fungi**.

The **ascomycetes** derived their names from the production of asci (singular, ascus) cells in which two haploid nuclei from different mating types come together and fuse, forming a diploid nucleus that undergoes meiosis to form haploid ascospores

Asexual reproduction in ascomycetes is by the production of conidia formed at the tip of specialised hyphae called conidiospore

The Basidiomycota include the Basidiomycetes, commonly known as __
club fungi

Examples of Basidiomycota include **jellyfungi, puffballs, toadstools and mushrooms**

There are Only about __ species of glomeromycetes are currently known.

160

Microsporidea are tiny (2-5µm), unicellular parasite of animals and protists. They have been considered protists and are sometime cited as such.

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Glomeromycota form endomycorrhizae with plants roots.

___ are named after their basidium which carries 4 basidiospores

Basidiomycota

Algae are generally classified on the basis of the following characteristics:

- **nature and properties of pigment**
- **chemistry of reserve food products or assimilatory products of photosynthesis**
- **type and number, insertion (point of attachment), and morphology of flagella**
- **chemistry and physiological features of cell walls**
- **morphological characteristics of cells and thalli**
- **life history, reproductive structures and method of reproduction.**

The Rhodophycophyta are also called **red algae**

The **Rhodophycophyta, or red algae**, are marine forms found in the warmer seas and oceans, but some grow in colder water as well as in fresh water.

Xanthophycophyta are also called The **Yellow-Green Algae**

Chrysophycophyta are also called The **Golden Algae**

Phaeophycophyta are also called The **Brown Algae**

Bacillariophycophyta are also called The **Diatoms**

Diatoms are unicellular, colonial, or filamentous and occur in a wide variety of shapes

Diatoms produce shells (cell walls) containing silica, some of which are very beautiful. Shells of diatoms are called frustules

Euglenophycophyta is also called The **Euglenoids**

___ are unicellular organisms and they are actively motile by means of flagella.

Euglenophycophyta

Chlorophycophyta is also called The **Green Algae**

Volvox is a colonial green algae which may form water blooms. Its colonies are visible to the naked eye

Desmids are one of the most interesting green algae found in a wide variety of attractive shapes and designs.

Ulothrix is a filamentous form found in flowing streams, attached to wings or stones by holdfasts at the base of the filament

A very common green alga is ___

Spirogyra

Cryptophycophyta is also called The **Cryptomonads**

The **cryptomonads** are a small group of biflagellate organisms

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An example of cryptomonads is the **genus Cryptomonas**.

The Examples of Rhodophycophyta are **Gelidium and Polysiphonia**

Amoebas get their name from the Greek word "**amoibe**", meaning **"change"**

A typical example of amoeba is **Amoeba proteus**.

The **ciliates** are protozoa with cilia for locomotion.

Common examples of the ciliated protozoa are included in the **genus Paramecium**

Phytomastigophora are divided into **two** groups which are__

The plant like forms class Phytoflagellates which have chlorophyll and flagella forms, class Zoomastigophora which have no chlorophyll and are heterotrophic

__ is the study of inheritance (heredity) and the variability of the characteristics of an organism.

Genetics

__ exacts transmission of genetic information from parents to their progeny (offspring).

Inheritance

Deoxyribonucleic acid (DNA) is the chemical substance responsible for hereditary in all cells because it beams the genetic information

Variability or variation of the inherited characteristics occurs or alters as a result of change in the genetic makeup of a cell or in environmental conditions.

Genetic Variation is changes in or of a gene which leads to a loss of the enzymes or to the production of an altered enzymes, hence, to recognizable changes in the hereditary character

Genetic variation in bacteria can take place by:

- **mutation**
- **gene transfer or recombination.**

Mutation can be defined as a change in the nucleotide sequence of DNA.

Mutation can involve the addition, deletion or substitution of nucleotides.

A **mutant** is a strain of any cell or virus carrying a change in the nucleotide sequence.

A mutant is different from its parent strain in:

- **Genotype**
- **The Phenotype**

The observable property of the mutant in the altered phenotype is called a **mutant phenotype**.

The nucleotide sequence of the genome is called__

Genotype

The strain isolated originally from nature is called the **wild type strain**.

Mutation can occur spontaneously or induced under the influence of external agents (mutagens).

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___ is mutation that occurs without exposure to external agents or any known mutagenic treatment

Spontaneous Mutation

___ occurs at a fairly constant frequency in a particular organism, one per 10^6 to 10^{10} in a population derived from a single bacterium

Spontaneous Mutation

Mutation arising from error in DNA replication can be ___

- **Transition Mutation**
- **Transversion Mutation**

Mutations as result of lesions on DNA which result in apurine sites, apyrimidinic sites, oxidation of DNA

Mutation as a result of the insertion of DNA segments into genes. Insertion usually inactivates genes.

___ is mutation caused by external agent (mutagens), which may be physical or chemical agents.

Induced Mutation

There are **three** main types of mutagenic chemicals. these are ___

- **Base analogs**
- **DNA Modifying Agents**
- **Intercalating Agents**

Intercalating Agents are chemicals with flat molecules that can intercalate (slip in) between base pairs in the central stack of the DNA helix

DNA Modifying Agents are chemicals that react chemically with DNA. They change a base structure and alter its base pairing characteristics

Base analogs are chemicals structurally similar to normal DNA bases and can be substituted for them during DNA replication.

There are **Two** common types of mutation are ___

point mutation and frame shift mutation.

Point mutations occur as a result of the substitution of one nucleotide for another in the specific nucleotide sequence of a gene or defined as change in only one base pair.

The most common type of point mutations are:

- **Silent mutation**
- **Missense Mutations**
- **Nonsense Mutation**

___ causes the early termination of translation and therefore results in a shortened polypeptide

Nonsense Mutation

___ involves a single base substitution that changes a codon for one amino acid into a codon for another.

Missense Mutations

Change the nucleotide sequence of a codon but do not change the amino acid encoded by that codon is called **Silent mutation**

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Frame Shift Mutations are mutations result form an addition or loss of one or more nucleotides in a gene and are termed insertion or deletion mutations respectively.

A mutation from wild type to a mutant form is called a **forward mutation**

___ is the formation of a new genotype by reassortment of genes following an exchange of genetic material between two different chromosomes which have similar gene at corresponding sites and are from different individuals
Genetic Recombination

In bacteria, genetic recombination's result from three types of gene transfer, they are:

- **Conjugation**
- **Transduction**
- **Transformation**

___ is the transfer of genes between cells that are in physical contact with one another.

Conjugation

___ is the transfer of genes from one cell to another by a bacteriophage

Transduction

___ is the transfer of cell free or naked DNA from one cell to another.

Transformation

___ is a mechanism of genetic transfer that involves cell to cell contact. It is plasmid encoded mechanism i.e. it is controlled by gene carried by certain plasmid (such as F plasmid)

Conjugation

The F plasmid (F stands for fertility) is a circular DNA molecule of **99159 bp**

___ is a genetic transfer process by which free DNA is incorporated into a recipient cell and brings about genetic change

Transformation

___ is a mechanism of genetic transfer in which a bacterial virus (bacteriophage) transfers DNA from one cell to another.

Transduction

Virus can transfer the host genes in two ways:

i generalised transduction and ii specialised transduction

Any gene on the donor chromosome can be transferred to the recipient since they carry any of the host chromosome, they are called **generalised transduction**

When a bacteria cell is infected with a phage, the ___ cycle is initiated.

Lytic

In **specialised transduction**, DNA from a specific region of the host chromosome is integrated directly into the virus genome usually replacing some of the virus genes.

Life on earth would not be possible without___

microbes

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Soil microorganisms serve as biogeochemical agents for the conversion of complex organic compounds into simple inorganic compounds or into their constituents' elements. The overall process is called **Mineralisation**.

Biogeochemical cycling refers to the biological and chemical processes that elements such as carbon, nitrogen, sulfur, iron and magnesium undergo during microbial metabolism

Biogeochemical cycling is the movement of materials via biochemical reactions through biospheres

the **Biosphere** is that portion of the earth and its atmosphere in which living organisms occur.

Biosphere

Biosphere also refers to the biological and chemical processes that elements such as carbon, nitrogen, sulfur, iron and magnesium undergo during microbial metabolism.

Biogeochemical cycling

Biogeochemical cycling can also be defined as cyclical path that elements take as they flow through living (biotic) and non-living (abiotic) components of the ecosystem

Biogeochemical cycling

Elements involved in the biogeochemical cycles are used for three general purposes. which are ____

- **Biomass Production**
- **Energy Source**
- **Terminal Electron Acceptor i.e. Carbohydrate Oxidised to CO₂**

The Peculiar Features of Biogeochemical Cycles are ____

- **Elements required are in five forms and mostly from non-living reservoir in the atmosphere**
- **The elements go in cycle and are always free in inorganic state in abiotic environment and when needed in biotic environment, they are turned to organic state.**
- **The recycling of these elements maintains a necessary balance of nutrient and they are maintained throughout**
- **The cycles (biogeochemical) are complex and they involve the activity of producers, consumers and decomposers**
- **All organisms participate directly in recycling by removing, adding or altering nutrients.**
- **The total turnover rate of element is most rapid in atmosphere and lowest in sedimentary rocks.**

The **carbon cycle** primarily involves the transfer of carbon dioxide and organic carbon between the atmosphere where carbon occurs principally as inorganic CO₂ and the hydrosphere and lithosphere which contain varying concentrations of organic and inorganic compounds.

The carbon cycle begins with **carbon fixation**, which is the conversion of CO₂ to organic matter

The term **greenhouse gas** describes the ability of these gases to trap heat within earth's atmosphere, leading to a documented increase in the planet's mean temperature

Nitrogen is an essential component of DNA, RNA and proteins, which are the building blocks of life, hence all organisms require nitrogen to live and grow.

the most abundant substance in the atmosphere or air is called **Nitrogen**

Three processes carried out by microorganisms are critical in the nitrogen cycle. They are:

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- **nitrogen fixation**
- **nitrification and**
- **denitrification.**

Nitrogen Fixation is strictly a bacterial process in which molecular nitrogen is converted to ammonium ion and it is the only naturally occurring process that makes nitrogen available to living organisms.

___ process brings nitrogen from the atmosphere to the hydrosphere and lithosphere.

Nitrogen Fixation

___ bacteria are found in high numbers or concentration in the rhizosphere (the region where the soil and roots make contacts).

Free Living Nitrogen Fixing Bacteria

Trichodesmium fix nitrogen aerobically while free-living anaerobes such as members of the genus *Clostridium* fix nitrogen anaerobically.

___ is a process carried out by chemolithotrophic bacteria which convert ammonium ions to nitrate (NO_3^-) ions.

Nitrification

___ is a two step process whereby ammonium ion is first oxidised to nitrite (NO_2^-) which is then oxidised to nitrate.

Nitrification

Denitrification is a process in which nitrate is removed from the ecosystem and returned to the atmosphere as dinitrogen gas (N_2) through a series of reactions

Ammonification is the decomposition process that converts organic nitrogen into ammonia (NH_3).

Sulphur can exist in several oxidation states within organic and inorganic compounds

___ is derived solely from the weathering of phosphate – containing rocks, hence in soil.

Phosphorus

The first step in carbon cycle is **carbon fixation** which is the conversion of CO_2 to organic matter by organisms such as Cyanobacteria

___ is used for food preservation.

Lactic acid

In food preparation, microbes are reduced to acceptable levels using methods such as addition of vinegar and ___
pasteurization

Human insulin and human growth hormone are produced by ___ bacteria.

Genetically engineered

Gram stain was developed in the year ___
1884

The microscope used in the examination of unstained organisms suspended in fields is called ___ microscope.
dark field

Alcoholic fermentation was found to be catalyzed by ___

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living yeast cells

A system of surgery designed to prevent microorganisms from entering wounds was developed by___
Joseph Lister

Beijerinck and___ pioneered the use of enrichment cultures and selective media
Winogradsky

The class of microorganisms that has growth optima around 20 C° to 45 C is___
mesophiles

Another name for phenol is___
Carbolic acid

___ are the most plentiful form of plankton in the Arctic.
Diatoms

Systematic classification of fungi is based on sequence analyses of___ RNA.
18S r

The Basidiomycota are known as___ fungi
club

Cell division in *Saccharomyces cerevisiae* occurs by___
budding

Heat – sensitive liquids and gases are sterilized by the use of___ method.
Filtration

Based on the source of energy bacteria can be classified as phototrophs and___
chemotrophs

The vegetative structure of a fungus is called a___
thallus

The union of a special male structure called a spermatium with a female reproductive structure is called___
spermatization

___ are large thick walled spores formed when the tips of two sexually compatible hyphae fuse together.
Zygospore

Spoilage of meat and / or vegetables in cold storage can be caused by some___
fungi

Most microorganisms cannot be seen without___
magnification

___ coined the term cell
Robert Hooke

Bacteria were first discovered in the year___
1676

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The first person to publish an extensive, accurate observation of microorganisms was____
Anthony Van Laeuwenhoek

____- was awarded the 1905 nobel prize for physiology or medicine.
Robert Koch

A phase in the growth curve during which there is no increase in cell number of a microbial population is called____phase
lag

A form of asexual reproduction process in which a single cell divides into two cells after developing a transverse septum is called____
binary fission

Simple acellular entities that can only reproduce within living cells are called____
viruses

A regular polyhedron with twenty equilateral triangle faces and twelve vertices is known as____
icosahedra capsid

____ is the simplest virus
Nucleocapsid

Bacteria are divided into____ volumes based on Bergey manual of systematic bacteriology
four

The shells of diatoms are Called____
Frustules

Viruses can exist in extracellular and____ phases.
Intercellular

Types of fixation are heat And____
Chemical

The Domains of microorganisms include Bacteria, Eucarya and____
Archaea

The mechanism of genetic transfer that involves cell to cell contact is known as____
conjugation

A mutation that involves a single base substitution that changes a codon for one amino acid into a codon for another is called____mutation
missence

____- postulated the germ theory of disease.
Louis Pasteur

The genus of bacteria used to introduce DNA into plants is____
Agrobacterium

The genus of bacteria that causes STD mostly of humans and animals is____

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Neisseria

A change in the nucleotide sequence of DNA is described as____
mutation

The genera of bacteria that can cause diphtheria is____
Corynebacterium

The genus of bacteria that is responsible for skin abscesses is____
Staphylococcus

The process by which nitrogen is removed from the ecosystem and returned to the atmosphere is known as____
denitrification

____ test is used to screen for mutagens and potential carcinogens.
Amen

The cell wall of bacteria is made up of____
peptidoglycan

Most bacterial capsules consist of____
polysaccharides

A cluster of bioflagella is Called____
Amphitrichous

The process by which microorganisms are used to recover metals from their ores is called____
bioleaching

____ can be used for the generation of mechanical, electrical and heat energy
methane

The instrument used for moist heat sterilization is____
autoclave

The process by which microorganisms lose viability at very high temperatures is known as____
denaturation

The process by which all living cells, spores and acellular entities are either destroyed or removed from an object or inhibited is called____
sterilization

Nitrification is carried out by____ bacteria.
Chemolithotrophic

The strain isolated originally from nature is called the____ type strain.
Wild

Shift____ occurs when a culture of microorganisms is transferred from a nutritionally poor medium to a richer one.
Up

Organisms that are damaged by normal atmospheric level of oxygen and require oxygen level below the range of 2 to 10 % for optimum growth are classified as____
Micropaerophiles

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The genus of bacteria that are aerobes or facultative anaerobes that form irregular clusters by dividing into two or more planes is___

Micrococcus

___ is the most common abundant element in the atmosphere

nitrogen

The group of bacteria that converts nitrite to nitrate is___

Nitrococcus

Microorganisms are named according to___ system.

Binomial

The basic taxonomic group in microbial taxonomy is the___

species

Microorganisms that are able to live in environments high in sugar as a solute are called___

osmophiles

Microorganisms that grow well at 0° C and have an optimum temperature of 15° C or below are classified as___

Psychrophiles

The mean growth rate constant (K) is the reciprocal of the___

generation time

The two main areas of research in Microbiology are basic and___

applied

The branch of Microbiology that deals with microbial processes in lakes, rivers, and the ocean is called___

Aquatic and Marine Microbiology

In the 20th Century, era of molecular microbiology began in the___

1970s

The concept of chemo – lithotrophy was proposed by___

Sergei Wingrasksky

___ disproved and defeated the theory of spontaneous generation

Louis Pasteur

___ - is the colonial green algae which form water blooms.

Volvox

The reddish colour of red algae results from___

phycoerythrin

Many unicellular green algae are motile by___ _action.

Flagella

Compounds that have the ability to inhibit the growth and metabolism of microorganisms are called___ agents.

Antimicrobial

___ is used to disinfect effluents from sewage treatment

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Chlorine

Who supported the theory of spontaneous generation?

John Needham

A microscope in which the magnified image formed by the objective lens is further enlarged by one or more additional lenses is known as:___

Compound microscope

The formation of diphtheria tetanus antitoxins was induced by:___

Joseph Lister

The most commonly used differential staining procedure is:

Simple staining

The process by which the internal and external structures of cells and microorganisms are preserved and fixed in a position is known as:

Fixation

The acid used as a pharmaceutical to supply calcium to the body is:

Gluconic acid

Which of the following genera of bacteria are aerobes or facultative anaerobes that form irregular clusters by dividing into two or more planes?

Micrococcus

Mutation can involve the ____ of nucleotides. I. division, II. addition, III. Deletion

III and II

The vaccine for the disease anthrax was developed between the period:

1880 – 1890

The microscope used to study microbial motility and determining the shape of line cells is:

Phase contrast Microscope

The most commonly used differential staining procedure is:

Simple staining

The acid used as a pharmaceutical to supply calcium to the body is:

Gluconic acid

A system of surgery designed to prevent microorganisms from entering wounds was developed by:

Joseph Lister

Alcoholic fermentation was found to be catalyzed by:

Living yeast cells

The major difference between prokaryotic and eukaryotic cells is:

Prokaryotic cells lack membrane bound organelles while eukaryotic cells possess membrane bound organelles

In bacterial cells, the capsules:

Promote attachment of bacteria to surfaces

Chemotrophs are:

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Bacterial that obtain their energy by oxidizing inorganic chemical compounds

Virus purification can be described as_
isolating the viral particle in its pure state

Into how many volumes are bacteria divided based on Bergey manual of systematic bacteriology?
4

Examples of fungi include :I .Mushroom, II. Euglena III.Yeast
I and III

Biochemistry deals with:
The study of microbial enzymes and the reactions they carry out

____ statements best describe the term systematics?
the scientific study of organisms with the ultimate objective of arranging them in an orderly manner

How many phases has the growth curve?
4

The most commonly used differential staining procedure is:
Simple staining

Facultative organisms can grow under the following conditions: I. Acrobic , II. Alcoholic, III. Anaerobic
I and III

___ are spores formed by budding?
Blastospores

_____ was the first to grow bacteria on solid culture media to get pure culture.
Robert Koch

_____ deals with the discovery of microbial enzymes and the chemical reactions they carry out.
Biochemistry

The branch of Microbiology which studies the structures of microbial cells is called _____.
Microbial Cytology

_____ are essential animal nutritional factors.
Vitamins

Protists which have different forms at different stages of their life cycles are called -- _____.
Slime Moulds

Protozoa are normally found in ___ habitat.
moist

Protozoa exist in free living and _____ forms.
symbiotic

_____ is a plant hormone is formed by the fungus.
Gibberellic acid

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The avoidance of infection and food spoilage by eliminating microorganisms from the surrounding is termed ____.
hygiene

Microorganisms from the surroundings can be totally removed by ____ method.
Sterilization

Microbes are used in biogas reactions to produce ____.
Methane/natural gas

The bacteria ____ recover copper and uranium from their ores.
Thiobacillus feroxidans

Biological warfare is otherwise known as ____ warfare.
Germ

An increase in the number of cells in a population of microorganisms is referred to as ____.
growth

In microbes that have cell walls, the membrane shrinks away from the cell wall by a process called ____.
plasmolysis

The use of incinerator is an example of ____ sterilization.
Dry heat

The killing, inhibition or removal of organisms that may be capable of causing disease is termed ____.
disinfection

Bacteria are 0.5 to ____ μm in diameter.
1.0

Based on their source of nutritive energy, bacteria are classified as ____ and ____.
Phototrophs, Chemotrophs

Bacterial cell wall is made up of ____.
peptidoglycan

Bacteria are classified based on differences in the ____ of cell wall
composition

____ act as protection against drying and bacteriophages
Capsules/Capsule

Fungi comprise the molds, mushrooms and ____.
yeasts

The vegetative structure of a fungus is called ____.
thallus

____ are the most numerous microorganisms on earth.
Viruses

____ can be used for detecting and isolating mutants.
replace planting

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A _____ is a strain of any cell carrying a change in the nucleotide sequence.
mutant

Paramecium moves rapidly by _____ beating of the cilia.
rhythmic

Classification of Protozoa is by the use of _____.
general characteristics

Phytomastigophora are divided into _____ groups.
Two/2

The Rhodophycophyta are found in the _____ habitat.
aquatic

The fungal cell is usually enclosed in a cell wall of _____.
chitin

Yeasts reproduce sexually through _____.
spore formation

In Fungi, hyphae with cross walls are called _____.
septate

In Fungi, hyphae without cross walls are called _____.
Coenocytic/aseptate

Obligate anaerobic fungi are found in the _____.
rumen of cattle

Asexual reproduction is also called _____ reproduction
Somatic/vegetative

The sex organelles of fungi are called _____.
gametangia

_____ are important research tools in the study of fundamental Processes.
Fungi

The most numerous microorganisms on earth are _____.
Viruses

The smallest viruses are a little larger than _____.
ribosomes

Virus particles can be counted indirectly by the _____ assay.
hemagglutination

Nutrition in protozoa is _____,
heterotrophic

_____ are used to degrade biological and industrial effluents.

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Protozoa/Protozoans

An open culture is also called a ____ culture.

continuous

Two major types of continuous culture system commonly used are chemostats and ____.

turbidostats

Microbial growth measurement helps to determine the growth rate and ____.

generation time

The total number of microbial cells can be achieved by using ____ methods

direct count

The amount of water available to microorganism is expressed in terms of the ____.

water activity

Moist heat sterilization involves the use of ____.

Autoclave

Which of the following is not a characteristic of the mycobacterium?

they are either anaerobes or preferentially anaerobic

Which of the following is not a feature of the Endospore form gram – positive bacteria?

they have a fermentative type of metabolism

Which of the following bacteria is associated with plant roots, nitrogen fixation?

Azospirillum

Which of the following is not a microbial taxonomic rank?

Number of children in a family

The following processes result in variation in microorganisms except ____.

gene association

The following are external structure of a bacterial cell wall except ____.

spores

The following are physiological and metabolic characteristics used in classifying microorganisms except ____.

osmotic concentration

Which of the following radiation types induces the formation of thymine dimers and strand breaks in DNA?

ultraviolet radiation

Which of the following classes of microorganisms has growth optima around 20° C to 45° C?

Mesophiles

Atmospheric nitrogen is directly useable by most organisms but has to be converted to stable organic form such as ____ and ____

Ammonium and Nitrate

Which of the following statements is not correct about raw data?

it lacks heterogeneity

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The microscope used to observe living unstained cells and organisms as a result of change in the way they are illuminated is ____.

Dark field microscope

The following are types of staining except ____.

Chemical fix staining

A biological weapon may be used to ____ a person.

All of the options

The following are types of microbial warfare agent except ____.

algae

Microorganisms possess the following characteristics except ____.

reproduction by binary fusion

shapes of bacterial cells except ____.

radial

The following are flagella types except ____.

Limphotrichous

The following are types of asexual spores in fungi except ____.

Chemydospores

The following are methods of sexual reproduction in fungi except ____.

Genital copulation

Molds and yeasts are used in the production of the following except ____.

soy-milk

Molds and yeasts are important research tools in the study of the following fundamental processes except ____.

medicine

Viruses differ from living cells in the following ways except ____.

they have both DNA and RNA in almost all virons

The following are characteristic of viruses except ____.

they range in size from 20-400µm

The following are types of capsid symmetry except ____.

isohedral

The following are characteristic of algae except ____.

they are prokaryotic organisms

__ is not an economic product derived from algal cell wall.

Succinate

The following are locomotory organelles in protozoa except ____.

Lenticels

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The following are means of reproduction in prokaryotes except ____.

binary fusion

____ is not a step of septation

linkage of the Z ring to the septum

The following are phases of microorganisms' growth curve except ____.

Lap

The following are methods of measuring total cell number of organisms except ____.

spectrophotometry

The following are disadvantages of the viable counting methods except ____.

they are simple technique sensitive

Prokaryotes that have growth optima between 80°C and 115°C are called ____.

Hyperthermophiles

____ is not a physical method used for sterilization.

high temperature

Autoclaving uses ____ under pressure.

Steam

The following are characteristics of an ideal disinfectant except ____.

it must have a high surface tension

____ are used as disinfectants in hospital and laboratories.

Phenolics

____ can both sterilize and disinfect. I. formaldehydes II. alcohols III. glutaraldehydes

I and III

____ is not a method used in the classic approach to taxonomy.

Genetic

____ is not a characteristic used in the classic approach to determining microbial taxonomy and phylogeny

biochemical

The following are the genera of the Spirochetes except ____.

Brucella

Aerobic bacteria whose cell walls contain large amounts of lipids are called ____ bacteria

Coryne

Gram-negative, non-phototrophic bacteria that obtain energy for CO₂ fixation from the oxidation of Ammonia are known as ____ bacteria.

Chemolithotrophic

Divisions within Bergey Manual of Systematic Bacteriology is based on the following characteristics except ____.

cell size

Volume ____ bacteria are made up of bacteria with unusual properties based on the Bergey Manual of Systematic Bacteriology.

3

____ are the earliest and simplest group of fungi.

Chytridiomycetes

____ are tiny unicellular parasites of animals and plants.

Microsporidea

Systematic classification of fungi is based on ____ I. sequence analyses of 18S r RNA II some protein coding genes. III. Characteristics of sexual spores.

I, II and III

Single cells, filamentous algae with pale green or yellow green pigments are known as ____.

Xanthophycophyta

Flagella is a _____ organelle in protozoa.

Locomotory

Amoeba and Paramecium are examples of _____

Protozoa

Some species of bacteria are able to change their forms especially when grown on artificial media. They are said to be

Pleomorphic

____ is a sealed heating device that allows the entrance of steam under pressure.

An autoclave

The _____ growth Phase in which the microorganisms are dividing at the maximal rate would be determined by their genetic potential, the nature of the medium, and the environmental conditions under which they are growing

Exponential

The _____ can be expressed mathematically as

growth rate (R)

Measurement of Total Cell Number is done using _____

Spectrophotometry

The _____ of a mold consists of long branched threadlike filaments of cells called hyphae.

Thallus

Microbial population death is exponential or logarithmic means that the population will be reduced by the same fraction at _____

constant interval

_____ are large thick walled spores formed when the tips of two sexually compatible hyphae or gametangia fuse together.

Zygospores

Yeasts can reproduce asexually by _____ and traverse division.

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budding

The killing of _____ is accomplished by applying steam under pressure at a temperature of 121oC

Heat-resistant

_____ agent is a natural or synthetic chemical that kills or inhibits the growth of microorganisms.

An antimicrobial

The various morphology types of viruses results from the combination of a particular type of capsid symmetry with the presence or absence of an envelope which is a lipid layer external to the _____

Nucleocapsid

Algae are unicellular microorganisms that have _____ and are photosynthetic.

Chlorophyll

Small aquatic forms of algae make up a large part of the free-floating microscopic life in water called _____

Plankton

Heavy algal growth may form _____ which interfere with the use of some natural waters for recreational purposes

Blanket

In sexual reproduction, the process of the fusion of two algal gametes that are different is called _____

Heterogamous

In parasitic protozoa, the developmental stages are often transmitted from host to host within a _____

Cyst

Each has The single site on the circular chromosome at which replication starts is called the _____

origin of replication

If a young, actively growing microbial culture is transferred to a fresh medium of the same composition, the _____ will be short or absent.

lag phase

_____ is the time required for a population to double.

Generation time

An apparatus designed to permit the growth of bacterial cultures at controlled rates and constructed so that sterile medium is fed into the culture vessel at the same rate as the spent media containing microorganisms is removed is referred to as _____

Chemostat

The use of an oven at a temperature of 150 to 160oC for 2 to 3 hours can also be used to sterilise _____

glass wares

_____ is defined as the science of biological classification.

Taxonomy

_____ classification is the grouping of microorganisms together based on the mutual similarity of the phenotypic characteristics.

Phenotypic

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_____ similarity is often a good indication of phylogenetic relatedness.

Morphological

_____ are the earliest and the simplest group of fungi.

Chytridiomycetes

All known species of glomeromycetes form _____ with the roots of herbaceous plants.

Endomycorrhizae

_____ can be defined as a change in the nucleotide sequence of DNA

Mutation

A _____ is a strain of any cell or virus carrying a change in the nucleotide sequence.

Mutant

The carbon cycle primarily involves the transfer of _____ and organic carbon between the atmosphere where carbon occurs principally as inorganic CO₂ and the hydrosphere and lithosphere which contain varying concentrations of organic and inorganic compounds.

carbon dioxide

Biogeochemical cycling of elements is the movement of materials via biochemical reactions through _____

Biospheres

In the _____ growth phase, although the cell is metabolically active synthesizing new components, there is no cell division and growth.

Lag

Yeasts can reproduce asexually by _____ and traverse division.

Budding

The diagram above is an example of ____.

Animal cell

loops used in the laboratory during the culturing of bacteria can be sterilised in

A bench top incinerator

In bacteria, genetic recombination does not result from _____

Detection

Which of the following is not a peculiar feature of the biogeochemical cycles?

Elements required are in five forms and mostly from living reservoir in the atmosphere.

The concept of spontaneous generation states that ____.

living organisms could develop from non-living matter

That microorganisms are the cause of infectious diseases is referred to as ____

Germ Theory of Disease

The following are basic aspects of microbiology except ____

Medical microbiology

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Which of the following is not an expected future challenge for microbiology?

New approach to increase environmental pollution and climate change

In a compound microscope, the magnified image formed by the objective lens is further enlarged by ____
one or more additional lenses

Based on their source of energy bacteria are classified as ____

Phototrophs and chemotrophs

These are stick like bacteria with rounded, square, tapered or swollen ends. They measure 1-10µm in length by 0.3-1.0µm in width. Which shape of bacteria does this describe?

Rod

Uncommon shapes of bacteria includes the following except

Palisade arrangement cells

Which of the following describes flagella?

These are hair like, helical appendages that protrude through the cell wall, 0.01 – 0.02µm in diameter and simple in structure. Based on their location on the cell, they may be polar or lateral.

Which of the following best explain the functions of bacterial sheaths?

They increase surface area of the cell for nutrient absorption. Some sheaths also have adhesive substances that aid attachment to surfaces.

Structures internal to the cell wall include the following except

Cilia

What is fungal mycelium?

Fungal mycelium is a complex of several filaments called hyphae.

Reproduction in fungi can either be ____ or ____.

asexual or sexual

What is sexual reproduction?

Sexual reproduction is a type of reproduction in which two parents give rise to offspring that have unique combinations of genes inherited from the gametes of the two parents

Which of the following is not a method of sexual reproduction in fungi?

Antheridium

Which of the following is not a beneficial use of fungi?

Fungi do not cause disease to man and animal but to plants.

The following are characteristics of viruses except

They are not infectious agents.

Which of the following is not a function of viral capsids?

Capsids self-assemble from many copies of one or a few types of proteins

Which of the following is not a type of capsid symmetry?

Bacteriophage

Which of the following is correct about the first step in the life cycle of a virus and host?

The first step in the life cycle of a virus attached to a host because viruses need a host cell in which to reproduce.

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Which of the following is a reason why viruses cannot be cultured in the same way as prokaryotic and eukaryotic microorganisms?

Viruses are unable to reproduce independent of living cells

How are animal viruses cultured?

By inoculating suitable host animals, embryonated egg or in tissue (cell) culture on monolayers of animal cells

The quantity of viruses in a sample can be determined directly by
counting particle numbers using the electron microscope.

The quantity of viruses in a sample can be determined indirectly by
measurement of an observable effect of the virus using techniques such as the hemagglutination assay

Biological and economic importance of algae include the following except
Algae are photosynthetic eukaryotic microorganisms.

Multicellular algae appear in every conceivable forms, shape and degree of complexity including the following except
Zoospores

What are the features that distinguish protozoa from other eukaryotic protists?
Their ability to move at some stage of their life cycle and by their lack of cell walls.

Which of the following is not an applied aspect of microbiology?
Bacteriology