MIC501 – MICROBIOLOGY

FINAL TERM MOST IMPORTANT QUESTIONS

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GROUP LINK: https://chat.whatsapp.com/BjC6W0jZx8o9yaC2ISh1Gu

1. What is integral protein?

An integral protein is a type of membrane protein that is permanently embedded within the cell membrane. These proteins span across or are deeply inserted into the phospholipid bilayer, making them essential for various cellular functions.

Types of Integral Proteins

Transmembrane Proteins – These proteins completely span the membrane and have regions exposed on both the extracellular and intracellular sides.
Integral Monotopic Proteins – These are embedded in only one side of the membrane.

2. Explain Acid Fast Staining.

Acid-Fast Staining

Acid-fast staining is a differential staining technique used to identify acid-fast bacteria (AFB), particularly members of the genus *Mycobacterium* and *Nocardia*. These bacteria have a high lipid content in their cell walls, mainly mycolic acids, which make them resistant to conventional stains like Gram staining.

Procedure:

Primary Staining – The bacterial smear is heat-fixed, and carbol fuchsin (a lipid-soluble red dye) is applied, followed by heating to allow dye penetration.
Decolorization – The slide is treated with acid-alcohol, which removes the stain from non-acid-fast bacteria but not from acid-fast bacteria.
Counterstaining – A counterstain like methylene blue or brilliant green is applied to color non-acid-fast bacteria.

Results:

- Acid-fast bacteria → Red/pink (retain carbol fuchsin)
- Non-acid-fast bacteria → Blue/green (take up the counterstain)

This technique is widely used in medical microbiology to detect Mycobacterium tuberculosis (tuberculosis) and Mycobacterium leprae (leprosy) in clinical samples.

3. What is inflammation and its characteristics?

Inflammation

Inflammation is the body's protective response to injury, infection, or harmful stimuli. It is a part of the immune response that helps eliminate the cause of damage, clear out dead cells, and initiate tissue repair. Inflammation can be acute (short-term) or chronic (long-lasting).

Characteristics of Inflammation (Cardinal Signs):

The classic signs of inflammation were first described by the Roman physician Celsus and later expanded by Virchow:

- ***Rubor (Redness)*** – Due to increased blood flow (vasodilation).
- ***Calor (Heat)*** – Increased blood flow and metabolic activity at the site of injury.
- ***Tumor (Swelling)*** – Fluid accumulation (edema) due to increased permeability of blood vessels.
- ***Dolor (Pain)*** – Caused by the release of chemical mediators like prostaglandins and bradykinin.
- ***Functio Laesa (Loss of Function)*** – Tissue damage or swelling can impair normal function.

4. Write a note on sexual reproduction cycle of fungi.

Sexual Reproduction Cycle of Fungi

Fungi reproduce sexually through a process involving the fusion of gametes or specialized reproductive structures, leading to the formation of genetically diverse offspring. The sexual reproduction cycle in fungi typically consists of three main stages:

1. Plasmogamy (Fusion of Cytoplasm)

- The first step in fungal sexual reproduction is plasmogamy, where the cytoplasm of two compatible haploid cells (n) fuses.
- The nuclei remain separate, leading to a dikaryotic (n + n) stage in some fungi, such as Basidiomycota and Ascomycota.

2. Karyogamy (Fusion of Nuclei)

- The haploid nuclei from the two parent cells fuse, forming a diploid (2n) zygote nucleus.
- This stage is often brief, as fungi quickly proceed to meiosis.

3. Meiosis (Formation of Haploid Spores)

- The diploid nucleus undergoes meiosis, producing haploid sexual spores.
- These spores are genetically diverse and serve as a means of dispersal and survival.

5. Write characteristics of magnetosomes.

Characteristics of Magnetosomes

Magnetosomes are membrane-bound, iron-rich organelles found in magnetotactic bacteria (MTB) that allow them to sense and align with Earth's magnetic field (magnetotaxis). These specialized structures help bacteria navigate aquatic environments efficiently.

Key Characteristics:

- ***Iron-Rich Nanoparticles*** – Composed of magnetite (Fe_3O_4) or greigite (Fe_3S_4), giving them magnetic properties.
- ***Membrane-Bound*** – Each magnetosome is enclosed by a lipid bilayer derived from the bacterial membrane.
- ***Chain-Like Arrangement*** – Magnetosomes align in a chain within the bacterial cell, acting like a tiny compass needle.
- ***Facilitates Magnetotaxis*** – Helps bacteria move along magnetic field lines, aiding in navigation toward optimal oxygen concentrations in aquatic environments.
- ***Biomineralization*** – Formed through controlled biomineralization, ensuring uniform crystal size and shape.
- ***Species-Specific Variability*** – Different bacteria produce magnetosomes of varying sizes, shapes, and compositions.
- ***Potential Applications*** – Used in biotechnology, nanomedicine, and environmental remediation due to their magnetic properties.

6. Define vaccine.

A vaccine is a biological substance designed to stimulate the body's immune system to recognize and fight specific pathogens, such as viruses or bacteria. It typically contains weakened or inactivated forms of the pathogen, its toxins, or fragments like proteins, prompting the immune system to produce antibodies and memory cells for future protection against the disease.

7. Define epidemiology and its methods.

Epidemiology is the study of the distribution, determinants, and patterns of health and disease conditions in populations. It aims to understand how diseases spread, their causes, and the impact on public health.

Methods of Epidemiology:

- ***Descriptive Epidemiology****:* Focuses on the distribution of diseases in terms of time, place, and person.
- ***Analytical Epidemiology****:* Investigates the causes or determinants of health problems by comparing groups (e.g., case-control and cohort studies).
- ***Experimental Epidemiology****:* Involves controlled experiments, often clinical trials, to study the effects of interventions or treatments.
- ***Ecological Studies****:* Examines health data at the population level to explore associations with environmental or social factors.
- ***Cross-sectional Studies****:* Collects data from a population at a single point in time to assess the prevalence of diseases or risk factors.

8. What is PCR? Name its steps.

Polymerase Chain Reaction (PCR) is a molecular biology technique used to amplify specific DNA sequences, allowing for the detection and analysis of genetic material.

Steps of PCR:

- ***Denaturation (94–98°C):*** DNA strands separate due to high temperature.
- ***Annealing (50–65°C):*** Primers bind to complementary DNA sequences.
- ***Extension (72°C):*** DNA polymerase synthesizes new DNA strands by adding nucleotides.

9. What is Disk Diffusion theory?

Disk Diffusion Theory is a microbiological method used to evaluate the effectiveness of antimicrobial agents against bacteria. It is the basis of the Kirby-Bauer disk diffusion test, commonly used in laboratories to assess antibiotic susceptibility.

Principle:

A paper disk impregnated with an antibiotic is placed on an agar plate inoculated with bacteria. As the antibiotic diffuses into the agar, it inhibits bacterial growth, creating a **zone of inhibition** around the disk. The size of this zone determines the bacteria's susceptibility to the antibiotic.

Key Factors Affecting Disk Diffusion:

- Antibiotic concentration in the disk
- Rate of antibiotic diffusion
- Bacterial growth rate
- Agar composition and thickness

10. Write properties of Ideal Chemical.

Properties of an Ideal Chemical:

- ***High Efficacy –*** Performs its intended function effectively.
- ***Stability*** – Maintains chemical integrity over time under various conditions.
- ***Non-Toxic*** – Safe for humans, animals, and the environment.
- ***Biodegradable*** – Breaks down naturally without causing pollution.
- ***Selective Action*** – Targets only the desired substance or organism without harming others.
- ***Non-Corrosive*** – Does not damage surfaces, equipment, or containers.
- ***Solubility*** – Easily dissolves in appropriate solvents for proper application.
- ***Low Cost & Availability*** – Economical and readily accessible.
- ***Non-Flammable & Non-Explosive*** – Safe to store and handle.
- ***Minimal Residue*** – Leaves no harmful byproducts after use.

11. What are types of symbiosis?

Symbiosis is a close and long-term biological interaction between two different species. There are several types of symbiosis:

1. **Mutualism (+/+)** – Both organisms' benefit. Example: Bees and flowers (bees get nectar, flowers get pollinated).
2. **Commensalism (+/0)** – One organism benefit, while the other is neither helped nor harmed. Example: Barnacles on whales (barnacles get transportation, whales are unaffected).
3. **Parasitism (+/−)** – One organism benefit (parasite), while the other is harmed (host). Example: Ticks on dogs (ticks feed on blood, harming the dog).
4. **Amensalism (0/−)** – One organism is harmed, while the other remains unaffected. Example: A large tree shading smaller plants (small plants get less sunlight).
5. **Neutralism (0/0)** – Both species coexist without affecting each other significantly. Example: Cactus and spider in a desert (neither directly benefit or harms the other).
6. **Competition (−/−)** – Both species are harmed due to limited resources. Example: Lions and hyenas competing for prey.

12. Write role of thin colonies selection.

The selection of thin colonies plays a crucial role in microbiology, particularly in bacterial culture techniques and genetic studies. Here are some key roles:

- ***Isolation of Pure Colonies*** – Thin colonies help in selecting individual bacterial strains, reducing the risk of contamination.
- ***Better Observation of Morphology*** – Thin colonies allow clearer visualization of colony shape, size, color, and other characteristics, aiding in species identification.
- ***Efficient Screening of Mutants*** – In genetic studies, thin colonies help in identifying mutants based on specific traits like antibiotic resistance or metabolic activity.
- ***Facilitates Staining and Microscopy*** – Thin colonies are easier to stain and observe under a microscope, improving analysis accuracy.
- ***Reduces Overcrowding*** – Thin colonies prevent excessive bacterial growth, ensuring that individual colonies develop properly without merging.
- ***Enhances Antibiotic Sensitivity Testing*** – Thin colonies allow better diffusion of antibiotics in susceptibility testing, leading to more accurate results.

13. What are types of microscopes?

Microscopes are classified based on their working principles and applications. Here are the main types:

i. Light Microscopes (Optical Microscopes)

Use visible light and lenses to magnify small objects.

- ***Brightfield Microscope*** – Most common; uses light passing through the specimen.
- ***Darkfield Microscope*** – Uses a dark background to enhance contrast for transparent specimens.
- ***Phase-Contrast Microscope*** – Enhances differences in refractive index, useful for observing live cells.

- ***Fluorescence Microscope*** – Uses fluorescent dyes and UV light to visualize specific cellular components.

ii. Electron Microscopes

Use electron beams instead of light for higher resolution.

- ***Transmission Electron Microscope (TEM)*** – Provides detailed internal structures by transmitting electrons through a thin specimen.
- ***Scanning Electron Microscope (SEM)*** – Produces 3D images of surface structures by scanning the specimen with electrons.

iii. Scanning Probe Microscopes

Used for imaging surfaces at the atomic level.

- ***Atomic Force Microscope (AFM)*** – Measures surface forces to create highly detailed 3D images.
- ***Scanning Tunneling Microscope (STM)*** – Detects electron flow between the microscope tip and specimen, used for atomic-level imaging.

14. How infection enters into a healthy person?

Infections enter a healthy person through different **modes of transmission**, depending on the type of pathogen. Here are the main ways:

1. Direct Contact Transmission: Person-to-person contact like Touching, kissing, or sexual contact (e.g., STDs like HIV, herpes). Animal-to-person contact like Bites or scratches from infected animals (e.g., rabies).
2. Indirect Contact Transmission: Fomites (contaminated objects) such as Touching infected surfaces like doorknobs, medical instruments (e.g., flu, MRSA).
3. Droplet Transmission: Respiratory droplets from coughing, sneezing, or talking (e.g., COVID-19, influenza, tuberculosis).
4. Airborne Transmission: Tiny aerosols stay in the air and are inhaled (e.g., measles, tuberculosis).
5. Waterborne Transmission: Drinking or swimming in contaminated water (e.g., cholera, typhoid).
6. Foodborne Transmission: Eating contaminated food (e.g., salmonella, food poisoning).
7. Vector-Borne Transmission: Insects or animals carry pathogens (e.g., malaria from mosquitoes, Lyme disease from ticks).
8. Bloodborne Transmission: Through blood transfusions, needle-sharing, or unsterile medical tools (e.g., hepatitis B, HIV).
9. Mother-to-Child Transmission: During pregnancy, childbirth, or breastfeeding (e.g., HIV, syphilis).

15. Explain flagellum and write its functions.

Flagellum: Definition & Structure

A **flagellum** (plural: **flagella**) is a long, whip-like structure that extends from the surface of certain cells and is used for movement. It is found in bacteria, archaea, and eukaryotic cells like sperm cells.

Types of Flagella:

- **Bacterial Flagella** – Made of flagellin protein; rotates like a propeller.
- **Archaeal Flagella** – Structurally different from bacterial flagella but functions similarly.
- **Eukaryotic Flagella** – Made of microtubules in a 9+2 arrangement and moves in a wave-like motion.

Functions of Flagellum:

- ***Movement (Motility)*** – Helps cells move in liquid environments (e.g., sperm swimming, bacterial movement).
- ***Chemotaxis*** – Enables bacteria to move toward nutrients or away from harmful substances.
- ***Sensory Function*** – Detects environmental changes (e.g., temperature, pH, chemicals).
- ***Attachment*** – Some bacteria use flagella to attach to surfaces (e.g., Helicobacter pylori in the stomach).
- ***Biofilm Formation*** – Helps bacteria form protective communities on surfaces.

16. Explain structure of Algae.

Structure of Algae

Algae are simple, plant-like organisms that can be **unicellular** (single-celled) or **multicellular**. They lack true roots, stems, and leaves but have specialized structures for survival and growth. Their structure varies depending on the type of algae (e.g., green, red, brown, or blue-green algae).

General Structure of Algae:

- ***Cell Wall*** – Made of cellulose in most algae, but some (like brown algae) have alginates or silica (in diatoms).
- ***Plasma Membrane*** – Surrounds the cytoplasm, regulating the movement of substances.
- ***Cytoplasm*** – Contains all the cell's organelles.
- ***Chloroplasts*** – Contain chlorophyll and other pigments for photosynthesis (e.g., chlorophyll a, b, c, or d).
- ***Pyrenoids*** – Found inside chloroplasts; help in starch storage.
- ***Nucleus*** – Contains genetic material (DNA) and controls cell activities.
- ***Mitochondria*** – Produce energy through respiration.
- ***Flagella*** (in some algae) – Help in movement (e.g., Chlamydomonas has two flagella).
- ***Eyespot (Stigma)*** – A light-sensitive organelle in motile algae, helping in phototaxis (movement toward light).
- ***Vacuoles*** – Store water, nutrients, and waste products.

17. What are PAMPs?

Pathogen-Associated Molecular Patterns (PAMPs)

PAMPs (Pathogen-Associated Molecular Patterns) are conserved molecular structures found on pathogens (bacteria, viruses, fungi, and parasites) that are recognized by the immune system. They play a key role in triggering innate immunity by activating immune cells.

Characteristics of PAMPs:

- ***Highly Conserved*** – Found across different groups of microbes.
- ***Essential for Microbial Survival*** – Not easily mutated or lost.
- ***Recognized by Host Immune Receptors*** – Detected by Pattern Recognition Receptors (PRRs) like Toll-like receptors (TLRs) and NOD-like receptors (NLRs).

Examples of PAMPs:

PAMP	Found in	Example
Lipopolysaccharide (LPS)	Gram-negative bacteria	E. coli, Salmonella
Peptidoglycan	Gram-positive & Gram-negative bacteria	Staphylococcus, Streptococcus
Flagellin	Bacterial flagella	Motile bacteria
Lipopeptides & Lipoteichoic Acid	Gram-positive bacteria	Streptococcus
Unmethylated CpG DNA	Bacteria & viruses	Bacterial genomes
Viral RNA (dsRNA, ssRNA)	Viruses	Influenza, SARS-CoV-2
β-glucans & Mannans	Fungal cell walls	Candida, Aspergillus

18. Define viruses.

Definition

A virus is a microscopic infectious agent that can replicate only inside the living cells of a host organism. Viruses are non-living outside a host but become active once they infect a cell. They infect all life forms, including animals, plants, bacteria, and fungi.

Characteristics of Viruses:

- ***Acellular (Not a True Cell)*** – Lacks a nucleus, cytoplasm, or organelles.
- ***Obligate Intracellular Parasite*** – Can only reproduce inside a host cell.
- ***Composed of Genetic Material*** – Either DNA or RNA, but never both.
- ***Surrounded by a Protein Coat (Capsid)*** – Protects genetic material.
- ***May Have an Envelope*** – Some viruses (e.g., influenza, HIV) have a lipid envelope derived from the host cell membrane.
- ***Lack Metabolism*** – Cannot generate energy or synthesize proteins independently.

19. Define sporangiospores.

Sporangiospores are asexual reproductive spores produced inside a specialized sac-like structure called a sporangium. These spores are commonly found in fungi, particularly in zygomycetes like *Rhizopus* (black bread mould) and *Mucor*. The sporangium is typically located at the tip of a specialized filament called a sporangiophore, which elevates the spores for effective dispersal. When the sporangium matures, it bursts open, releasing the spores into the environment. Sporangiospores are lightweight and can be dispersed by air, water, or other external forces, allowing the fungus to colonize new habitats. These spores germinate under favourable conditions, developing into new fungal hyphae. Since sporangiospores are formed through mitosis, they are genetically identical to the parent fungus, ensuring rapid and efficient reproduction.

20. Name different layers of endospores.

Endospores have multiple protective layers that help them survive extreme conditions. The main layers include:

- ***Exosporium*** – The outermost thin, proteinaceous layer that provides additional protection.
- ***Spore Coat*** – A thick layer made of keratin-like proteins, protecting against chemicals and enzymes.
- ***Cortex*** – A thick peptidoglycan layer that helps in dehydration, making the spore resistant to heat.
- ***Core Wall*** – Surrounds the core and provides structural integrity.
- ***Core (Protoplast)*** – Contains the DNA, ribosomes, and essential enzymes in a dormant state.

21. Write a note on Algae.

Algae are simple, autotrophic organisms that can perform photosynthesis and are found in various aquatic environments, ranging from oceans to freshwater. They can be unicellular (like *Chlamydomonas*), colonial (such as *Volvox*), or multicellular (like *Ulva*, also known as sea lettuce). Algae are classified into different groups based on their pigment composition, including green algae (contain chlorophyll a and b), brown algae (contain chlorophyll c and fucoxanthin), and red algae (contain chlorophyll a and phycobilins). They play a crucial role in the ecosystem as primary producers, forming the base of the food chain in aquatic environments, and are a source of oxygen through photosynthesis. Additionally, algae are used in various industries, including food, pharmaceuticals, and biofuels.

22. Define Yeast, Mold and Mycology.

Yeast: Yeasts are unicellular fungi that reproduce primarily by budding or fission and are used in baking, brewing, and biotechnology.

Mold: Molds are multicellular fungi that grow in filamentous structures known as hyphae, commonly found on decaying organic matter.

Mycology: Mycology is the branch of biology that studies fungi, including their classification, structure, ecology, and uses.

23. Name two components that maintain pH of media.

Two components that maintain the pH of media are:

i. ***Buffer solutions*** – Substances like phosphate buffer or Tris buffer that resist changes in pH when acids or bases are added.

ii. ***Acid or Base*** – Weak acids like acetic acid or weak bases like ammonium hydroxide are used to adjust and stabilize pH levels in the medium.

24. Name antibiotics which cause cell wall inhibition.

Antibiotics that cause cell wall inhibition include:

- ***Penicillins*** – Inhibit bacterial cell wall synthesis by targeting the enzyme responsible for cross-linking peptidoglycan.
- ***Cephalosporins*** – Similar to penicillins, they interfere with cell wall synthesis.
- ***Vancomycin*** – Inhibits the formation of peptidoglycan in the bacterial cell wall.
- ***Carbapenems*** – Disrupt cell wall synthesis, similar to penicillins and cephalosporins.
- ***Bacitracin*** – Inhibits the dephosphorylation of the lipid carrier involved in cell wall synthesis.

25. Why viruses need living organisms to grow?

Viruses need living organisms to grow because they are obligate intracellular parasites. This means that they lack the necessary machinery for metabolism, energy production, and reproduction. A virus consists of genetic material (either DNA or RNA) enclosed in a protein coat, but it doesn't have the cellular structures required for replication. To reproduce, viruses must infect a host cell and hijack the host's cellular machinery to replicate their genetic material and produce new virus particles. The host cell provides the enzymes, ribosomes, and energy needed for the virus to replicate and assemble new virions (virus particles). Without a living host cell, viruses cannot multiply or carry out any life processes.

26. Explain hierarchy.

In microbiology, the concept of hierarchy is used to describe the organization and classification of living organisms, particularly microorganisms, in a systematic way. This hierarchical classification helps scientists' study and categorize diverse organisms based on shared characteristics and evolutionary relationships.

Hierarchical Classification in Microbiology:

Domain – The highest level of classification. Organisms are classified into three domains: Bacteria, Archaea, and Eukarya.

Kingdom – A domain is divided into kingdoms. For example, in the domain Eukarya, there are kingdoms like Protista, Fungi, Plantae, and Animalia.

Phylum – Organisms within a kingdom are grouped into phyla based on significant similarities in their body structure.

Class – Within a phylum, organisms are further divided into classes.

Order – Organisms within a class are divided into orders.

Family – Orders are divided into families.

Genus – Families are divided into genera (plural of genus), which include species with similar characteristics.

Species – The most specific level, where organisms are classified based on genetic similarity and ability to interbreed.

27. Write steps of sample preparation in western blotting.

Steps of Sample Preparation in Western Blotting

i. **Cell Lysis**:
   - ***Objective:*** To break open the cells and release the proteins.
   - Use a lysis buffer (containing detergents like SDS, salts, and protease inhibitors) to disrupt the cell membrane and preserve protein integrity.

ii. **Protein Quantification**:
   - ***Objective:*** To determine the total protein concentration in the sample.
   - Methods like the Bradford assay or BCA assay are used to measure protein concentration.

iii. **Protein Denaturation**:
   - ***Objective:*** To unfold proteins to their linear form for consistent separation.
   - Mix the protein sample with SDS (sodium dodecyl sulfate), reducing agents (like DTT or β-mercaptoethanol), and heat the mixture (usually at 95°C for 5-10 minutes) to break disulfide bonds and linearize proteins.

iv. **Cooling and Centrifugation**:
   - ***Objective:*** To remove insoluble debris.
   - After denaturation, the sample is cooled, then centrifuged to pellet cell debris and insoluble materials. The supernatant (protein extract) is collected for analysis.

v. **Loading the Sample**:
   - ***Objective:*** To load equal amounts of protein onto the gel for separation.
   - Mix the protein sample with a loading buffer that contains tracking dyes, then load the samples into the wells of the SDS-PAGE gel.

28. What are branches of Microbiology?

Microbiology is a broad field with several specialized branches that focus on different aspects of microorganisms and their interactions with the environment, humans, and other organisms. The main branches of microbiology include:

i. Bacteriology

The study of bacteria, their structure, function, classification, and their role in disease, food production, and environmental processes.

ii. Virology

The study of viruses, their structure, classification, replication, and their impact on hosts (animals, plants, and humans).

iii. ***Mycology***

The study of fungi, including yeasts, molds, and mushrooms. It involves their classification, structure, ecology, and roles in both beneficial and harmful processes (e.g., in medicine and food production).

iv. ***Parasitology***

The study of parasites and their interactions with host organisms. This includes protozoa, helminths, and arthropods, which can cause diseases in humans and animals.

v. ***Immunology***

The study of the immune system and how it defends against microorganisms and other pathogens. This branch also focuses on the body's response to infections, vaccines, and autoimmune diseases.

vi. ***Phycology (Algology)***

The study of algae, their classification, biology, and their ecological role, particularly in aquatic environments.

vii. ***Environmental Microbiology***

The study of microorganisms in natural environments such as soil, water, and air, including their roles in biogeochemical cycles, pollution control, and environmental remediation.

viii. ***Industrial Microbiology***

The application of microorganisms in industrial processes such as fermentation, antibiotic production, food and beverage manufacturing, and biotechnology.

ix. ***Medical Microbiology***

The study of microorganisms that cause human diseases, their transmission, diagnosis, treatment, and prevention. This branch is vital for understanding infectious diseases and developing medical interventions.

x. ***Food Microbiology***

The study of microorganisms in food, including their role in food spoilage, foodborne illnesses, fermentation processes, and food preservation.

xi. ***Agricultural Microbiology***

The study of microorganisms in agricultural settings, including their role in soil fertility, plant diseases, and biofertilizer production.

29. Define mortality, mobility and phylogeny.

Mortality: The state of being subject to death; the incidence of death within a population or organism.

Mobility: The ability of an organism or cell to move or be moved actively, often in response to environmental stimuli.

Phylogeny: The evolutionary history and relationship among species or organisms, often depicted as a branching tree of life.

30. What is colonial theory?

Colonial Theory

The Colonial Theory is a hypothesis that explains the evolution of multicellularity from unicellular organisms. It suggests that multicellular organisms evolved from colonies of single-

celled protists that lived together in cooperative groups. Over time, these cells became specialized for different functions, leading to the formation of true multicellular organisms. This theory is supported by the existence of colonial protists like Volvox, which show a transition between unicellular and multicellular life forms.

31. How infectious disease transfer from infected person to healthy person?

Transmission of Infectious Diseases

Infectious diseases can transfer from an infected person to a healthy person through various modes of transmission. These include:

- ***Direct Contact Transmission*** – Physical contact with an infected person, such as touching, kissing, sexual contact, or exposure to body fluids (e.g., HIV, COVID-19, influenza).
- ***Indirect Contact Transmission*** – Contact with contaminated surfaces, objects, or personal items like doorknobs, towels, or medical equipment (e.g., norovirus, MRSA).
- ***Airborne Transmission*** – Inhalation of tiny infectious droplets or aerosols released by coughing, sneezing, or talking (e.g., tuberculosis, measles, COVID-19).
- ***Droplet Transmission*** – Large respiratory droplets carrying pathogens spread through coughing or sneezing, typically within a short distance (e.g., influenza, COVID-19, whooping cough).
- ***Vector-Borne Transmission*** – Carried by insects or animals like mosquitoes (malaria, dengue), ticks (Lyme disease), or fleas (plague).
- ***Fecal-Oral Transmission*** – Ingestion of food or water contaminated with fecal matter containing pathogens (e.g., cholera, hepatitis A, typhoid).
- ***Bloodborne Transmission*** – Spread through infected blood or body fluids via needle sharing, transfusions, or childbirth (e.g., HIV, hepatitis B & C).
- ***Vertical Transmission*** – From mother to baby during pregnancy, childbirth, or breastfeeding (e.g., HIV, syphilis, rubella).

32. How pathogenic microorganisms cause damage to the body?

How Pathogenic Microorganisms Cause Damage to the Body

Pathogenic microorganisms cause disease by invading the body, multiplying, and disrupting normal physiological functions. They do this through several mechanisms:

- ***Invasion and Colonization*** – Pathogens enter the body through various routes (e.g., respiratory tract, digestive system, wounds) and attach to host tissues using specialized structures like pili, adhesins, or biofilms.
- ***Toxin Production*** – Many bacteria release toxins that harm host cells:
    1. **Exotoxins**: Proteins secreted by bacteria that cause direct damage (e.g., *Clostridium botulinum* produces botulinum toxin, leading to paralysis).
    2. **Endotoxins**: Components of bacterial cell walls (e.g., *Lipopolysaccharides* in Gram-negative bacteria) that trigger strong immune responses, causing inflammation and fever.
- ***Immune System Evasion*** – Pathogens use various strategies to avoid detection and destruction by the immune system, such as:

1. **Antigenic variation** (changing surface proteins, e.g., *Trypanosoma* in sleeping sickness).
2. **Hiding inside host cells** (*Mycobacterium tuberculosis* survives within macrophages).
3. **Producing immune-suppressing molecules** (HIV targets immune cells directly).

- ***Tissue Damage and Inflammation*** –
  1. Some pathogens directly destroy host cells by **lysing** them (e.g., viruses causing cell death after replication).
  2. Others trigger **inflammatory responses**, leading to swelling, pain, and tissue damage (e.g., *Streptococcus pyogenes* in strep throat).
- ***Nutrient Depletion*** – Some pathogens consume host nutrients, weakening the body. For example, *Plasmodium* (malaria parasite) destroys red blood cells, leading to anemia.
- ***Triggering Autoimmune Reactions*** – Some infections confuse the immune system, causing it to attack its own tissues (e.g., *Streptococcus* infections can lead to rheumatic fever).

33. List four different phases of growth curve.

The four different phases of the bacterial growth curve are:

- ***Lag Phase*** – The initial phase where bacteria adapt to their new environment, but there is no significant increase in cell number as they prepare for growth.
- ***Log (Exponential) Phase*** – Bacteria multiply rapidly at a constant rate, leading to an exponential increase in population. This is the most active phase of growth.
- ***Stationary Phase*** – Growth rate slows down as nutrients become limited and waste products accumulate. The number of new cells equals the number of dying cells.
- ***Death (Decline) Phase*** – The population decreases as bacteria die due to lack of nutrients and toxic waste accumulation.

34. What is chemical sterilization?

Chemical sterilization is a method of eliminating all forms of microbial life, including bacteria, viruses, fungi, and spores, using chemical agents. It is commonly used for heat-sensitive medical instruments, plastics, and delicate equipment that cannot withstand high temperatures.

Common Chemical Agents Used for Sterilization

1. ***Ethylene Oxide (EtO)*** – A gaseous sterilant used for sterilizing medical devices and equipment.
2. ***Glutaraldehyde*** – A liquid disinfectant effective against bacteria, viruses, and spores.
3. ***Hydrogen Peroxide Vapor*** – Used for sterilizing enclosed spaces like operating rooms and medical tools.
4. ***Peracetic Acid*** – A strong oxidizing agent used in medical and food industries.
5. ***Formaldehyde*** – Used as a gas or solution for sterilization but is less commonly used due to toxicity concerns.

Advantages of Chemical Sterilization

- Suitable for heat-sensitive materials.
- Effective against a wide range of microorganisms, including spores.
- Can penetrate complex structures and instruments.

Disadvantages

- Some chemicals can be toxic and require proper ventilation.
- May leave residues that need thorough removal.
- Longer exposure time compared to other sterilization methods.

35. Explain procedure of dry heat method.

Dry heat sterilization uses high temperatures to kill microorganisms by oxidizing cellular components and denaturing proteins. It is typically used for sterilizing equipment that cannot be exposed to moisture, such as glassware, metal instruments, and powders.

Steps Involved in Dry Heat Sterilization:

- **Preparation of Materials:**
  1. Clean and decontaminate items that need to be sterilized.
  2. Ensure items are dry, as the method relies on heat and cannot tolerate moisture.
  3. Place the items in suitable containers or trays that allow for heat circulation.
- **Loading the Sterilizer:**
  1. Arrange the materials in the dry heat sterilizer (e.g., an oven) so that air can circulate around them.
  2. Avoid overloading to ensure uniform heat distribution.
- **Setting the Temperature and Time:**
  1. ***Temperature:*** Typically, dry heat sterilization is performed at temperatures ranging from 160°C to 180°C (320°F to 356°F).
  2. ***Time:*** The sterilization cycle can last from 1 to 2 hours, depending on the temperature and type of material being sterilized.
  3. The higher the temperature, the shorter the required exposure time, but excessive heat can damage the materials.
- **Heating and Sterilization:**
  1. Turn on the sterilizer and allow it to reach the desired temperature.
  2. Maintain the required temperature for the full sterilization time.
  3. Heat is transferred by convection and radiation to destroy microbial cells, including spores.
- **Cooling Down:**
  1. After the sterilization period is complete, allow the materials to cool in a clean, dry environment before handling.
  2. The sterilized items can then be stored in sterile containers to avoid contamination.

36. Define viral plaque.

A viral plaque is a clear zone or area of cell destruction formed in a monolayer of cultured cells due to viral infection and replication. Each plaque represents the lysis (breaking down) of host cells by a single infectious virus particle, which then spreads to nearby cells, forming a visible plaque. This method is commonly used in plaque assays to quantify viruses in a sample.

37. Name drugs for inhibition of cell wall, protein and nucleic acid synthesis.

Drugs for Inhibition of Cell Wall, Protein, and Nucleic Acid Synthesis

Cell Wall Inhibitors (Target peptidoglycan synthesis)

- Penicillins (e.g., Ampicillin, Methicillin)
- Cephalosporins (e.g., Ceftriaxone, Cephalexin)
- Carbapenems (e.g., Imipenem, Meropenem)
- Monobactams (e.g., Aztreonam)
- Glycopeptides (e.g., Vancomycin, Teicoplanin)
- Bacitracin

Protein Synthesis Inhibitors (Target ribosomes)

- Aminoglycosides (e.g., Streptomycin, Gentamicin, Tobramycin)
- Tetracyclines (e.g., Doxycycline, Minocycline)
- Macrolides (e.g., Erythromycin, Azithromycin, Clarithromycin)
- Chloramphenicol
- Lincosamides (e.g., Clindamycin)
- Oxazolidinones (e.g., Linezolid)

Nucleic Acid Synthesis Inhibitors (Target DNA/RNA replication or transcription)

- Quinolones & Fluoroquinolones (e.g., Ciprofloxacin, Levofloxacin) – Inhibit DNA gyrase
- Rifamycins (e.g., Rifampin, Rifabutin) – Inhibit RNA polymerase
- Metronidazole – Disrupts DNA structure in anaerobic bacteria
- Sulfonamides & Trimethoprim (e.g., Sulfamethoxazole + Trimethoprim (Co-trimoxazole)) – Inhibit folic acid synthesis, indirectly affecting nucleic acid synthesis

38. Explain Viral replication and its mechanism.

Viral replication is the process by which viruses multiply inside a host cell, as they lack their own cellular machinery. The general steps include:

- ***Attachment*** – Virus binds to specific receptors on the host cell.
- ***Penetration*** – Virus enters the cell via endocytosis or membrane fusion.
- ***Uncoating*** – Viral genome is released into the host cell.
- ***Replication*** – The viral genome is copied using host or viral enzymes.
  1. ***DNA viruses*** replicate in the nucleus (e.g., Herpesvirus).
  2. ***RNA viruses*** replicate in the cytoplasm (e.g., Coronaviruses).
  3. ***Retroviruses*** use reverse transcriptase (e.g., HIV).
- ***Assembly*** – New viral particles are formed inside the host cell.
- ***Release*** – Viruses exit by lysis (bursting the cell) or budding (enveloped viruses acquire a membrane).

39. What are stages of viral replication?

The stages of viral replication are:

1. ***Attachment*** – The virus binds to specific receptors on the host cell surface.
2. ***Penetration*** – The virus enters the host cell via endocytosis or fusion with the host membrane.
3. ***Uncoating*** – The viral capsid is removed, releasing the viral genome into the host cell.
4. ***Replication and Transcription*** – The viral genome is replicated and transcribed by the host cell machinery.
5. ***Translation*** – Host cell ribosomes translate viral RNA into proteins.
6. ***Assembly*** – Newly synthesized viral genomes and proteins are assembled into complete virions.
7. ***Release*** – New virions exit the host cell by lysis or budding, spreading to infect other cells.

40. Which factors determine composition and distribution of microbiota?

The composition and distribution of microbiota are determined by several factors:

- ***Host Factors*** – Genetics, immune system, and health conditions (e.g., diseases, antibiotic use).
- ***Environmental Factors*** – Diet, lifestyle, hygiene, and exposure to pathogens or microbes.
- ***Age*** – Microbiota composition varies from infancy to adulthood.
- ***Geography*** – Different regions may have distinct environmental conditions that shape microbiota.
- ***Diet*** – Types of food influence microbial diversity, such as fiber-rich foods supporting beneficial bacteria.
- ***Antibiotics and Medications*** – Can disrupt microbial balance, leading to shifts in microbiota.
- ***Host's Body Environment*** – pH, oxygen levels, and temperature in various body sites (e.g., gut, skin, mouth).

41. Define Endemic, Pandemic and Epidemic.

Endemic: A disease or condition regularly found and consistently present in a specific geographic area or population.

Pandemic: An outbreak of a disease that occurs over a wide geographic area, often worldwide, and affects a large number of people.

Epidemic: A sudden increase in the number of cases of a disease above what is normally expected in a specific area or population.

42. Define Pasteurization. Which samples are used in Pasteurization?

Pasteurization is a heat treatment process that kills harmful microorganisms in food and beverages without significantly affecting their taste, texture, or nutritional value. It involves heating the product to a specific temperature for a certain period and then rapidly cooling it.

Samples used in pasteurization:

Milk, Juices, Egg products, Canned foods, Beer.

43. Define Chlamydoconidium and sporangiospore.

***Chlamydoconidium**:* A type of asexual spore produced by certain fungi, which is thick-walled and serves as a survival structure under unfavourable conditions. It is formed by the swelling of a vegetative cell that eventually becomes a conidium.

***Sporangiospore**:* A type of asexual spore produced within a sporangium (a specialized structure) in certain fungi. The sporangium releases the spores into the environment for dispersal and germination.

44. Name factors that effect death rate of bacteria.

The factors that affect the death rate of bacteria include:

- ***Temperature*** – Higher temperatures typically increase bacterial death rates, while lower temperatures slow them down.
- ***pH*** – Extreme pH levels (acidic or alkaline) can disrupt bacterial metabolism and kill them.
- ***Oxygen Availability*** – Aerobic and anaerobic conditions affect bacterial survival based on their oxygen requirements.
- ***Moisture*** – Lack of moisture or desiccation can lead to bacterial death, as most bacteria require water for survival.
- ***Antibiotics and Disinfectants*** – The presence of antimicrobial agents can increase the rate of bacterial death.
- ***Nutrient Availability*** – Limited nutrients can lead to stress, decreasing bacterial viability and increasing death rates.
- ***Concentration of the Bacteria*** – Higher bacterial populations may have a different death rate than smaller populations due to competition for resources.
- ***Environmental Conditions*** – Factors such as humidity, light, and presence of other microorganisms can influence bacterial survival.
- ***Time of Exposure*** – Longer exposure to adverse conditions (heat, chemicals) increases the chances of bacterial death.

45. Define Conidia, Arthroconidia and Blastoconidia.

***Conidia**:* Asexual, non-motile spores produced by fungi, formed externally on specialized structures called conidiophores. They help in fungal reproduction and dispersal.

***Arthroconidia**:* A type of conidia formed by the fragmentation of hyphae into individual, rectangular or barrel-shaped spores. They are seen in fungi like *Coccidioides* and help in survival and spread.

***Blastoconidia**:* A type of conidia formed by budding from the parent fungal cell, commonly seen in yeasts like *Candida* and *Saccharomyces*.

46. Differentiate between Oxygenated Photoautotroph and Non-oxygenated Photoautotroph.

Oxygenated photoautotrophs and non-oxygenated photoautotrophs differ in their photosynthetic processes and byproducts. Oxygenated photoautotrophs, such as cyanobacteria, algae, and plants, perform oxygenic photosynthesis, where they use water as an electron donor and release oxygen as a byproduct. This process occurs in the presence of chlorophyll and follows the light-dependent and light-independent reactions to produce energy-rich organic compounds. In contrast, non-oxygenated photoautotrophs, like certain purple and green sulfur bacteria, carry out anoxygenic photosynthesis. Instead of water, they use alternative electron donors such as hydrogen sulfide (H_2S) or ferrous ions (Fe^{2+}), and thus, they do not produce oxygen. These organisms often inhabit extreme or anaerobic environments, such as sulfur springs or deep-sea hydrothermal vents, where oxygen is scarce. The fundamental distinction between the two lies in their electron donors and the presence or absence of oxygen release during photosynthesis.

47. Define Phyophyta, Rhodophyta, chlorophyta and dinoflagellates.

Phaeophyta (Brown Algae) – Phaeophyta is a group of mostly marine, multicellular algae characterized by their brown or olive-green color due to the presence of the pigment fucoxanthin. They belong to the class *Phaeophyceae* and are primarily found in cold, nutrient-rich waters. Examples include kelps (*Macrocystis*), rockweeds (*Fucus*), and *Sargassum*. Brown algae play an essential role in marine ecosystems, forming underwater forests that provide habitat for various marine organisms.

Rhodophyta (Red Algae) – Rhodophyta is a division of primarily marine, multicellular algae known for their red coloration due to the presence of phycoerythrin and phycocyanin pigments. They can live at greater depths than other algae due to their ability to absorb blue light efficiently. Red algae, such as *Porphyra* and *Gracilaria*, are economically important as sources of agar, carrageenan, and food products like nori.

Chlorophyta (Green Algae) – Chlorophyta is a division of predominantly freshwater algae that contain chlorophyll a and b, giving them a bright green color similar to land plants. Green algae include unicellular, colonial, and multicellular forms, such as *Chlamydomonas*, *Volvox*, and *Ulva* (sea lettuce). They share a close evolutionary relationship with terrestrial plants and contribute significantly to aquatic ecosystems through oxygen production and primary productivity.

Dinoflagellates – Dinoflagellates are a group of mostly unicellular, flagellated protists found in marine and freshwater environments. They belong to the phylum *Dinoflagellata* and are known for their bioluminescence and ability to cause harmful algal blooms, such as red tides. Some dinoflagellates, like *Symbiodinium*, form mutualistic relationships with coral reefs, while others, like *Alexandrium*, produce toxins that affect marine life and human health.

48. Describe two methods of microbial identification.

Microbial identification is essential in microbiology to classify and characterize microorganisms. Two common methods of microbial identification are biochemical testing and molecular techniques.

Biochemical Testing – This method involves analyzing the metabolic and enzymatic activities of microorganisms to differentiate between species. It includes tests such as the catalase test (to detect the presence of the catalase enzyme), oxidase test (to identify cytochrome c oxidase activity), and carbohydrate fermentation tests (to determine the ability to ferment specific sugars). Commercial identification systems, like API (Analytical Profile Index) strips, provide rapid biochemical profiling by testing multiple biochemical reactions simultaneously.

Molecular Techniques – These methods involve analyzing genetic material for microbial identification. One widely used technique is Polymerase Chain Reaction (PCR), which amplifies specific DNA sequences to detect and identify microorganisms. Another method, 16S rRNA sequencing, is used to classify bacteria based on variations in the highly conserved 16S ribosomal RNA gene. Molecular methods provide high specificity and accuracy, making them valuable for identifying unculturable or fastidious microorganisms.

49. Define Hyphae, Mycelium and Thallus.

Hyphae – Hyphae are the long, thread-like filaments that make up the body of fungi. They are tubular structures composed of chitin-rich cell walls and serve as the primary mode of fungal growth and nutrient absorption. Hyphae can be septate (divided by cross-walls called septa) or coenocytic (lacking septa, forming a continuous multinucleate cytoplasm).

Mycelium – Mycelium is the network of interconnected hyphae that forms the vegetative part of a fungus. It spreads through the substrate, such as soil or decaying organic matter, absorbing nutrients and supporting fungal growth. Mycelium can be extensive, forming visible structures like mold on food or underground fungal mats that contribute to ecosystem nutrient cycling.

Thallus – The thallus refers to the entire body of a fungus or other simple organisms like algae, which lack true roots, stems, or leaves. In fungi, the thallus consists of mycelium, and in some unicellular fungi like yeasts, it may exist as a single-celled structure. The thallus is responsible for growth, reproduction, and nutrient absorption.

50. Define Virus, Viroid and Virion.

Virus – A virus is a non-cellular, infectious agent composed of genetic material (either DNA or RNA) enclosed within a protein coat called a capsid. Some viruses also have an outer lipid envelope. Viruses are obligate intracellular parasites, meaning they require a host cell to replicate and produce new viral particles. They infect various organisms, including bacteria (bacteriophages), plants, animals, and humans, causing diseases such as influenza, HIV, and COVID-19.

Viroid – A viroid is a small, circular, single-stranded RNA molecule that can infect plants and cause diseases. Unlike viruses, viroids lack a protein coat and do not encode proteins. They rely on the host's cellular machinery for replication and interfere with normal cellular processes, leading to plant diseases such as potato spindle tuber disease.

Virion – A virion is a complete, fully assembled viral particle that exists outside a host cell. It consists of the viral genome, a protective protein coat (capsid), and, in some cases, a lipid envelope derived from the host cell membrane. The virion is the infectious form of a virus, capable of attaching to and infecting new host cells.

51. Enlist uses of Fungi.

Fungi have numerous applications in various fields, including medicine, industry, agriculture, and food production. Some important uses of fungi include:

1. **Medical Uses:**
   - Production of antibiotics (e.g., *Penicillium* produces penicillin).
   - Source of immunosuppressants (e.g., *Cyclosporine* from *Tolypocladium inflatum*).
   - Used in biotechnology for producing vaccines and enzymes.

2. **Food Industry:**
   - Used in fermentation for making bread (*Saccharomyces cerevisiae*).
   - Production of alcoholic beverages like beer and wine.
   - Used in cheese production (*Penicillium* species in blue cheese).
   - Edible mushrooms like *Agaricus bisporus* (button mushroom) and *Pleurotus* (oyster mushroom).

3. **Agricultural Benefits:**
   - Mycorrhizal fungi enhance plant nutrient absorption.
   - Used in biological control to suppress plant pathogens and pests.
   - Improve soil fertility through organic matter decomposition.

4. **Industrial Applications:**
   - Production of citric acid (*Aspergillus niger*).
   - Used in biofuel and enzyme production (e.g., cellulase, amylase).
   - Textile and paper industries use fungal enzymes for processing materials.

5. **Environmental Roles:**
   - Decomposers in ecosystems, breaking down organic matter.
   - Used in bioremediation to degrade pollutants and waste materials.