GOVERNMENT COLLEGE (A)
RAJAHMUNDRY

MICROBIOLOGY DEPARTMENT

III SEMESTER

COURSE 5

EUKARYOTIC MICROORGANISMS

III SEMESTER
COURSE 5: - EUKARYOTIC MICROORGANISMS
CREDITS - 3

Unit 1: Fungi **No. of Hours:9**

1. Habitat, distribution, nutritional requirements, fungal cell ultra- structure, fungal wall, Outline classification of Fungi
2. Reproduction in different fungal groups- Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes
3. Heterokaryosi s, heterothallism and parasexual mechanism.
4. Fungal dimorphism (Candida albicans)

Unit 2: Importance of Fungi **No. of Hours:9**

1. Role of fungi in biotechnology: food, medicine and pharmaceutical industry (baking, brewing, antibiotics, alcohols, enzymes, organic acids, and pharmaceuticals)
2. Beneficial Role of fungi in Agriculture: Biofertilizers, Myco toxins; Biological control (Myco fungicides, Myco herbicides, Myco insecticides).
3. Mushrooms and its cultivation. (White button, Milky and Oyster)
4. Fungi as plant and animal pathogens (Cercospora, Puccinia, Candida, Aspergillus)

Unit 3: Algae **No. of Hours:9**

1. Algae- occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves, outline classification
2. Vegetative, asexual and sexual reproduction in Algae
3. Photosynthetic apparatus, and outline of Photosynthesis in Algae

Unit 4: Importance and cultivation of Algae **No. of Hours:9**

1. Importance of algae in agriculture, industry, environment and food with examples.
2. Algal culture techniques- Indoor, Outdoor, Closed, Open, Batch, continuous, Fed batch
3. Culture media and growth parameters for algal cultivation (Spirulina)

Unit 5: Protozoa **No. of Hours:9**

1. General characteristics with special reference to Amoeba, Paramecium
2. Pathogenic Protozoa- Plasmodium, Leishmania and Giardia
3. Importance of protozoa (in waste management, soil fertility, industry and scientific study)
4. Culturing protozoans from natural sources-Hay water, pond water, Chalkley's solution
5. Haplobiontic (Nemalion), Haplontic (Chlamydomonas), Diplontic (Cladophora), Diplobiontic (Polysiphonia) and Diplohaplontic (Cladophora) life cycles.

Skill Outcomes:

On successful completion of the course, the students will be able to

1. Develop practical skills in the isolation, identification, and cultivation of fungi and algae.
2. Acquire knowledge about the preparation of growth media and study host- pathogen interactions.
3. Gain the ability to examine the vegetative and reproductive structures of selected genera through microscopy.
4. Demonstrate proficiency in purifying and preserving pure cultures of common algae and fungi.

PRACTICALS

1. Preparation of Potato Dextrose Medium.
2. Isolation and identification of pathogenic and non-pathogenic fungi.
3. Study of host-pathogen interaction.
4. Study of the vegetative and reproductive structures of following generathrough temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus* and *Alternaria*
5. Purification and preservation of pure cultures of common algae and fungi.

UNIT 1: FUNGI

Q. Describe Habitat, distribution, nutritional requirements, fungal cell ultra-structure, fungal wall, Outline classification of Fungi .

1. Habitat:

- Fungi can be found in a variety of habitats, including soil, water, decaying organic matter, and living organisms. They grow best in moist, warm environments.

2. Distribution:

- Fungi are distributed worldwide and are present in nearly every ecosystem. They are more common in temperate and tropical regions due to the favorable humidity and temperature conditions.

3. Nutritional Requirements:

- Fungi are heterotrophic, meaning they cannot produce their own food like plants. They obtain nutrients by absorbing dissolved organic matter from their surroundings. They can be:
    - **Saprophytic**: Feeding on dead organic matter.
    - **Parasitic**: Feeding on living organisms, often causing diseases.
    - **Symbiotic**: Forming mutually beneficial relationships with other organisms, like mycorrhizae with plants.

4. Fungal Cell Ultra-structure:

- Fungal cells are eukaryotic, meaning they have a true nucleus and other membrane-bound organelles. Key components include:
    - **Nucleus**: Contains the genetic material.
    - **Mitochondria**: Produce energy for the cell.
    - **Endoplasmic Reticulum and Golgi Apparatus**: Involved in protein synthesis and transport.
    - **Vacuoles**: Store nutrients and waste products.
    - **Plasma Membrane**: Surrounds the cell, controlling the movement of substances in and out.

5. Fungal Wall:

- The fungal cell wall is a rigid structure that provides support and shape to the cell. It is primarily composed of chitin. The cell wall also contains other polysaccharides like glucans and proteins.

6. Outline Classification of Fungi:

- Fungi are classified into several groups based on their characteristics:
    - **Chytridiomycota**: Simple, aquatic fungi with flagellated spores.
    - **Zygomycota**: Includes molds like Rhizopus, characterized by the formation of zygospores.
    - **Ascomycota**: Known as sac fungi, they produce spores in sac-like structures called asci. Examples include yeast and truffles.
    - **Basidiomycota**: Known as club fungi, they produce spores on basidia. Includes mushrooms and puffballs.

- **Deuteromycota (Fungi Imperfecti)**: A group of fungi for which sexual reproduction has not been observed. Many of these fungi are important in medicine, like Penicillium.

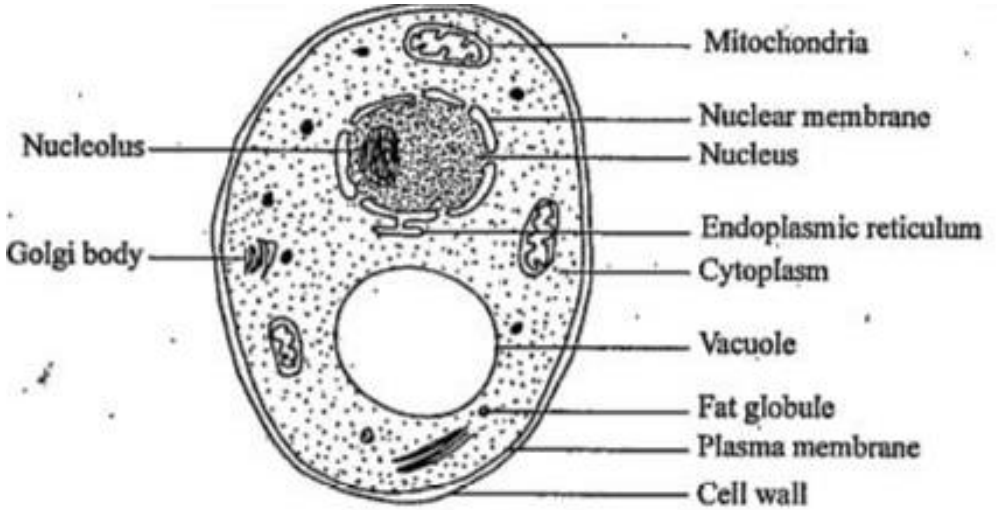

Fig : Yeast cell

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Q. Explain Reproduction in different fungal groups- Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes in simple english

1. Phycomycetes:

- **Asexual Reproduction**: This occurs through the production of spores called **sporangiospores** within a structure called a sporangium. When conditions are favorable, these spores are released and germinate into new fungi.
- **Sexual Reproduction**: This happens when two different mating types come together to form a thick-walled structure called a **zygosporangium**, which contains **zygospores**. These zygospores can withstand harsh conditions and will germinate when the environment becomes favorable again.

2. Ascomycetes:

- **Asexual Reproduction**: This occurs mainly through the production of **conidia**, which are asexual spores that form on the tips of specialized structures called conidiophores.
- **Sexual Reproduction**: Involves the formation of spores called **ascospores** inside a sac-like structure known as an **ascus**. Typically, eight ascospores are formed within each ascus. The asci are often contained in a fruiting body called an **ascocarp**.

3. Basidiomycetes:

- **Asexual Reproduction**: It is less common and, when it occurs, can involve the production of conidia or fragmentation of the mycelium.
- **Sexual Reproduction**: This is the main form of reproduction and involves the formation of **basidiospores** on specialized cells called **basidia**. Basidia are usually found on the gills, pores, or other structures of the fruiting body, known as a **basidiocarp** (e.g., mushrooms). Typically, four basidiospores are produced on each basidium.

4. Deuteromycetes (Fungi Imperfecti):

- **Asexual Reproduction**: This group is known as "Fungi Imperfecti" because their sexual reproduction has not been observed. They reproduce mainly through **conidia**, similar to Ascomycetes.
- **Sexual Reproduction**: Since sexual reproduction has not been discovered in these fungi, they are classified based on their asexual reproductive structures and molecular data.

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Q.write notes on Heterokaryosis, heterothallism and parasexual mechanism in fungi .

Q. HETEROKARYOSIS IN FUNGI - SPLIT ESSAY 4 MARKS

Heterokaryosis refers to the presence of two or more genetically distinct nuclei within a single fungal cell or hypha. This condition often arises during the fusion of hyphae from different fungal individuals.

- Heterokaryosis occurs when a fungal cell contains two or more genetically different nuclei within a single cell or hypha .
- This can occur when different spores fuse or when mutations arise in one nucleus but not in others.
- **Importance**: Heterokaryosis allows fungi to have genetic diversity without sexual reproduction. It can also provide advantages like better adaptation to the environment or resistance to diseases.

1. **Neurospora crassa**:
    - In this ascomycete fungus, heterokaryosis occurs naturally. When two different strains of *Neurospora crassa* fuse, their hyphae can combine to form a heterokaryotic mycelium, containing nuclei from both parent strains.
2. **Basidiomycetes**:
    - In many basidiomycete fungi, such as *Agaricus bisporus* (the common mushroom), heterokaryosis is common. During the sexual reproduction process, different mating types fuse to form a

dikaryotic (heterokaryotic) mycelium, where two distinct nuclei coexist in the same cell.

3. **Aspergillus nidulans**:
    - This ascomycete fungus also exhibits heterokaryosis. In laboratory settings, researchers often use *Aspergillus nidulans* to study the genetic mechanisms underlying heterokaryosis and its effects on fungal growth and development.

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HETEROTHALLISM IN FUNGI - SPLIT ESSAY 4 MARKS

- Heterothallism is a form of sexual reproduction in fungi where two different mating types are required to come together for reproduction to occur.
- In heterothallic fungi, each strain has either a "+" or "-" mating type. For sexual reproduction, a "+" mating type must find a "-" mating type. This ensures genetic diversity.
- **Examples**:

1. **Neurospora crassa**:
    - This fungus is also an example of a heterothallic organism. It has two mating types, A and a, and sexual reproduction can only occur when hyphae from these two different mating types come into contact.
2. **Puccinia graminis** (Wheat Stem Rust):
    - This basidiomycete fungus is heterothallic and requires two different strains for sexual reproduction. The life cycle of *Puccinia graminis* involves different hosts and alternates between dikaryotic and diploid stages, requiring two mating types to complete sexual reproduction.
3. **Rhizopus stolonifer**:
    - This zygomycete fungus, commonly known as black bread mold, is heterothallic. It has two mating types (+ and -), and sexual reproduction only occurs when hyphae from these two different types fuse to form a zygosporangium.

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Parasexual Mechanism IN FUNGI

- The parasexual mechanism is a non-sexual process that allows fungi to exchange and recombine genetic material without going through a typical sexual cycle.
- It involves several steps:
    1. **Fusion of Hyphae**: Two different fungal hyphae fuse, bringing different nuclei together.
    2. **Nuclear Fusion**: The different nuclei may fuse, forming a diploid nucleus (containing two sets of chromosomes).
    3. **Chromosome Loss**: The diploid nucleus may lose chromosomes during cell division, eventually returning to a haploid state (one set of chromosomes).
    4. **Recombination**: During these processes, genetic material can be shuffled, leading to new genetic combinations.

The parasexual cycle includes several steps: heterokaryosis, karyogamy, mitotic recombination, and haploidization.

- **Heterokaryosis** is the first step in parasexuality, where two or more distinct nuclei coexist in the same cell.
- **Karyogamy** leads to the formation of a diploid nucleus.
- **Mitotic recombination** creates new genetic combinations.
- **Haploidization** - The resulting diploid strains can lose chromosomes during mitosis, leading to the formation of new haploid strains with unique genetic characteristics.
- Examples - **Aspergillus nidulans, Penicillium chrsygenum**
- **Importance**: This mechanism allows fungi to increase genetic diversity without undergoing a full sexual reproduction cycle.

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Q. Write notes on Fungal dimorphism (Candida albicans)

Fungal Dimorphism:

- Fungal dimorphism refers to the ability of some fungi to exist in two different forms depending on environmental conditions. These two forms are usually a yeast-like form and a filamentous (mold-like) form.
- **Yeast Form**: In the yeast form, the fungus appears as single, round or oval cells that reproduce by budding. This form is typically found in environments like the human body, where the temperature is higher (around 37°C).

- **Filamentous Form**: In the filamentous form, the fungus grows as long, thread-like structures called hyphae. This form is often seen in the environment, like in soil, where temperatures are lower (around 25°C).

Candida albicans and Dimorphism:

- *Candida albicans* is a common fungal pathogen in humans. It can cause infections, especially in people with weakened immune systems, and is often found in the mouth, gut, and vagina.
- **Dimorphic Nature**: *Candida albicans* can switch between a yeast form and a hyphal (filamentous) form, depending on various factors like temperature, ph, and the presence of certain chemicals.
    - **Yeast Form**: This is the form typically seen in a healthy, balanced state in the human body. It is non-invasive and less harmful.
    - **Hyphal Form**: This form is often associated with infection and disease. The hyphae can invade tissues, leading to more severe infections.
- **Importance of Dimorphism**: The ability to switch between these forms is crucial for *Candida albicans*' survival and pathogenicity. The yeast form helps it to thrive in various body environments, while the hyphal form allows it to invade tissues and cause infections.
- **Role in Pathogenicity**: The dimorphic switch is often triggered by changes in the host environment, like a rise in temperature (fever) or changes in the immune response. This switch is a key factor in the fungus's ability to cause diseases like thrush, vaginal yeast infections, and systemic candidiasis.

Unit 2: Importance of Fungi

Role of Fungi in Biotechnology

Fungi play an important role in biotechnology. Fungi contribute to fields such as food production, medicine, pharmaceuticals, and industry.

FUNGI IN FOOD

Fermentation: Fungi are crucial in fermentation processes to produce various foods and beverages.

- **Bread**: Yeast (Saccharomyces cerevisiae) helps dough rise by producing carbon dioxide.
- **Beer and Wine**: Yeast ferments sugars to produce alcohol and carbon dioxide.
- **Cheese**: Molds like Penicillium roqueforti and Penicillium camemberti are used to produce blue cheese and soft cheeses like Camembert and Brie.

- **Citric Acid**: Produced by *Aspergillus niger*, used as a flavor enhancer and preservative
- **Enzymes**: Fungi produce enzymes like amylase, protease, and lipase, which are used in food processing to improve texture, flavor, and nutritional value.
- **Rhizopus spp.**: Produces enzymes used in food processing. Used in the production of tempeh and other fermented foods.
- **Mushrooms** like Agaricus bisporus, Milky mushrooms & oyster Cultivated for direct consumption.Mushrooms are rich in vitamins, minerals, and proteins.

FUNGI IN MEDICINE

- **Antibiotics**: Fungi produce antibiotics that can kill or inhibit bacteria.
  - **Penicillin**: Discovered from the mold Penicillium, it is one of the first and most widely used antibiotics.
- **Immunosuppressants**: Fungi produce compounds that can suppress the immune system.
  - **Cyclosporine**: Derived from the fungus Tolypocladium inflatum, it is used to prevent organ transplant rejection.
- **Cholesterol-lowering drugs**: Fungi produce statins, which are used to lower cholesterol levels.
  - **Lovastatin**: Derived from Aspergillus terreus.

FUNGI IN PHARMACEUTICALS

- **Production of Drugs**: Fungi are used in the production of various pharmaceutical drugs.
  - **Ergot Alkaloids**: Derived from the fungus Claviceps purpurea, used to treat migraines and induce labor.
- **Vaccine Production**: Some fungi are used to produce components of vaccines.

FUNGI IN INDUSTRY

- **Enzymes**: Fungi produce enzymes that are used in various industrial processes.
  - **Amylases**: Break down starch into sugars, used in brewing and baking.
  - **Cellulases**: Break down cellulose, used in textile and paper industries.
- **Biofuel Production**: Fungi can break down plant biomass to produce biofuels.
  - **Ethanol**: Produced by yeast fermentation of plant sugars.

- **Bioremediation**: Fungi help clean up environmental pollutants by breaking down toxic substances.
    - **Oil Spills**: Certain fungi can degrade hydrocarbons in oil spills.

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BENEFICIAL ROLE OF FUNGI IN AGRICULTURE

Fungi play various beneficial roles in agriculture, helping to improve soil health, control pests, and enhance crop yields.

FUNGAL BIOFERTILIZERS:

Mycorrhizal Fungi:
Arbuscular Mycorrhizae (AM):

- These fungi form symbiotic relationships with plant roots and help plants access nutrients like phosphorus, nitrogen, and micronutrients from the soil.
- **Benefits**: Improved nutrient uptake, enhanced plant growth, and better drought resistance.
- **Examples**: Glomus spp., Rhizophagus spp.

Ectomycorrhizae:

- These fungi form a sheath around plant roots and extend into the soil, facilitating nutrient and water absorption.
- **Benefits**: Increased nutrient uptake, improved plant health, and better resistance to soil pathogens.
- **Examples**: Laccaria spp., Amanita spp.

MYCOTOXINS

- These are Toxic compounds produced by certain fungi that can contaminate crops and food products.
- **Pest Control**: Some mycotoxins can be used to develop natural pesticides.
- **Example**: Aflatoxins from *Aspergillus* can be used in controlled settings to manage pest populations.
- **Health Risks**: Mycotoxins are generally harmful to humans and animals if ingested in large quantities. Proper management is essential.
- **Prevention and Control**:
- **Good Agricultural Practices**: Prevent mold contamination through proper storage and handling of crops.
- **Testing**: Regularly test crops and food products for mycotoxin contamination.

MYCOFUNGICIDES

Mycofungicides are beneficial fungi used to control plant diseases caused by other fungi.

Examples:

- **Trichoderma spp.**: Competes with harmful fungi, parasitizes them, and produces enzymes that degrade their cell walls.

  Use: Effective against soil-borne pathogens and root diseases.
- **Gliocladium spp.**: it acts as a biological control agent against plant pathogens.

Use: Used to manage fungal diseases in various crops.

Benefits:

- **Eco-Friendly**: Reduces reliance on chemical fungicides.
- **Effective**: Helps manage and reduce the impact of fungal plant diseases.

MYCOHERBICIDES

Mycoherbicides are Fungi used to control unwanted plants (weeds).

Examples:

Fusarium oxysporum:

- Infects and kills specific weed species.
- **Use**: Effective against certain types of weeds in crops.

Phytophthora palmivora:

- Targets and controls invasive plant species.
- **Use**: Used for managing weeds like strangler vine.

Benefits:

- **Targeted Control**: Can selectively control specific weed species without harming other plants.
- **Reduced Chemical Use**: Provides an alternative to chemical herbicides.

MYCOINSECTICIDES

Mycoinsecticides are Fungi used to control insect pests.

Examples:

Beauveria bassiana:

- it infects and kills insect pests .
- **Use**: Effective against a variety of insect pests, including whiteflies and aphids.

Metarhizium anisopliae:

- **Mechanism**: it infects and kills insect pests.
- **Use**: Used for controlling locusts, grasshoppers, and termites.

Benefits:

- **Biological Control**: Provides a natural way to manage insect pests.
- **Reduced Pesticide Use**: Helps decrease the need for chemical insecticides.

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Mushrooms and Their Cultivation

White Button Mushrooms (Agaricus bisporus) SPLIT ESSAY 4 MARKS

Mushrooms are a type of fungi that are cultivated for food. They come in various types, each with specific cultivation methods. Most common verities cultivated are white button mushrooms, milky mushrooms, and oyster mushrooms.

Characteristics:

- Most commonly cultivated and consumed mushroom.
- Small, white, and smooth cap.

Cultivation:

1. **Substrate Preparation**:
    - Use compost made from horse manure, straw, and other organic materials.
2. **Pasteurization**:
    - Treat the compost to kill unwanted organisms.
3. **Spawning**:
    - Mix mushroom spawn (seed) into the prepared compost.
4. **Casing**:
    - Cover the compost with a layer of peat moss or soil to retain moisture.
5. **Fruiting**:
    - Maintain high humidity and cool temperatures (12-18°C). Mushrooms will start to appear in a few weeks.
6. **Harvesting**:
    - Pick the mushrooms when the caps are fully developed but still closed.

Milky Mushrooms (Calocybe indica) SPLIT ESSAY 4 MARKS

Mushrooms are a type of fungi that are cultivated for food. They come in various types, each with specific cultivation methods. Most common verities cultivated are white button mushrooms, milky mushrooms, and oyster

mushrooms.

Characteristics:

- Large, white, and fleshy mushroom.
- Suitable for warm climates.

Cultivation:

1. **Substrate Preparation**:
    - Use straw or other agricultural waste as a substrate.
2. **Sterilization**:
    - Steam or chemically treat the substrate to kill unwanted organisms.
3. **Spawning**:
    - Mix mushroom spawn with the sterilized substrate.
4. **Incubation**:
    - Keep the substrate in dark, humid conditions (25-35°C) for the mycelium to colonize.
5. **Fruiting**:
    - Expose to light and maintain high humidity. Fruiting bodies will appear in a few weeks.
6. **Harvesting**:
    - Pick the mushrooms when they are fully grown but before the caps start to flatten.

Oyster Mushrooms (Pleurotus spp.) SPLIT ESSAY 4 MARKS

Mushrooms are a type of fungi that are cultivated for food. They come in various types, each with specific cultivation methods. Most common verities cultivated are white button mushrooms, milky mushrooms, and oyster mushrooms.

Characteristics:

- Known for their fan-shaped caps and mild flavor.
- Grows on a variety of substrates, including straw and sawdust.

Cultivation:

1. **Substrate Preparation**:
    - Use straw, sawdust, or other cellulose-rich materials.
2. **Pasteurization**:
    - Steam or hot-water treat the substrate to kill unwanted organisms.
3. **Spawning**:

- Mix mushroom spawn into the prepared substrate.

4. **Incubation**:
   - Keep the substrate in warm, dark conditions (20-30°C) for mycelium growth.
5. **Fruiting**:
   - Move to a cooler (15-20°C), humid environment with light. Fruiting bodies will start to form in a few weeks.
6. **Harvesting**:
   - Pick the mushrooms when the caps are fully developed but still firm.

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FUNGI AS PLANT AND ANIMAL PATHOGENS

Fungi as Plant Pathogens

Fungi can be major threats to plants, causing diseases that impact agricultural productivity.

Cercospora

- **Cercospora Leaf Spot**: Causes dark, round spots with grayish centers on leaves, leading to premature leaf drop.
- **Crops Affected**: Beans, tomatoes, lettuce, and other vegetables.
- **Symptoms**: Yellowing and spotting of leaves, which can lead to reduced photosynthesis and lower yields.

Prevention and Control:

- **Resistant Varieties**: Use crop varieties that are resistant to Cercospora infections.
- **Sanitation**: Remove and destroy infected plant debris to reduce fungal spores.
- **Crop Rotation**: Rotate crops to minimize the build-up of fungal spores in the soil.
- **Fungicides**: Apply fungicides as needed to manage outbreaks.

Puccinia

- Causes rust diseases characterized by reddish-brown pustules on leaves, stems, and grains.

Impact on Plants:

- **Rust Diseases**: Causes various types of rusts, including:
- **Wheat Rust (Puccinia graminis)**: Affects wheat, reducing yield and grain quality.
- **Barley Rust (Puccinia hordei)**: Affects barley, causing similar issues.
- **Symptoms**: Reddish-brown pustules on plant parts, leading to weakened plants and reduced crop yields.

Prevention and Control:

- **Resistant Varieties**: Plant rust-resistant crop varieties.
- **Sanitation**: Remove and destroy infected plant debris to limit spore spread.
- **Crop Rotation**: Rotate crops to break the lifecycle of the rust fungus.
- **Fungicides**: Use fungicides to control rust outbreaks.

Aspergillus

- **Species**: Includes A. flavus, A. fumigatus, A. niger, among others.
- **It appears as** Moldy growth, with a green or black color. Produces conidia (spores) in a brush-like structure.

- **Aspergillosis**: infections caused by Aspergillus species.

    - **Pulmonary Aspergillosis**: Affects the lungs, causing symptoms like cough, fever, and chest pain.
    - **Invasive Aspergillosis**: A serious infection that can spread to other organs, especially in immunocompromised individuals.
    - **Allergic Aspergillosis**: Causes allergic reactions in the lungs, leading to asthma-like symptoms.

Prevention and Control:

- Reduce exposure to moldy environments, especially for those with weakened immune systems.
- Maintain clean and dry environments.
- Use antifungal medications such as voriconazole or amphotericin B for treatment of infections.

Candida

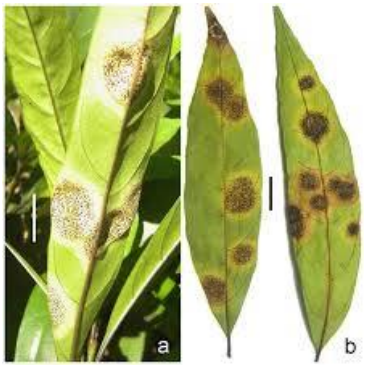
- **Species** Includes C. albicans , C. tropicalis, among others.
- **It is** yeast like fungi that can form pseudohyphae and yeast cells.
- **Candidiasis**: Infections caused by Candida species.

- **Oral Candidiasis (Thrush)**: White patches in the mouth or throat.
- **Vaginal Candidiasis**: Yeast infection causing itching, burning, and discharge.
- **Cutaneous Candidiasis**: Skin infections, often in moist areas.
- **Invasive Candidiasis**: Serious infection affecting the bloodstream and internal organs, particularly in immunocompromised patients.

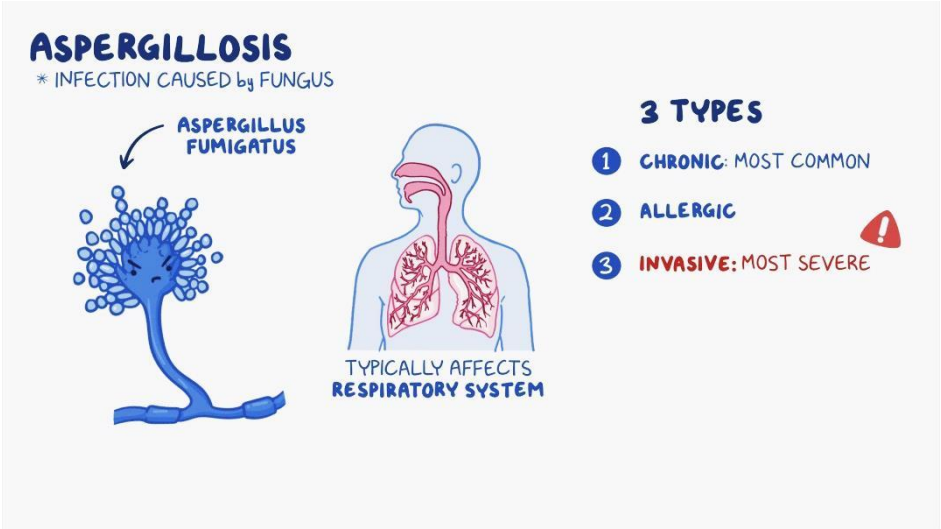
Prevention and Control:

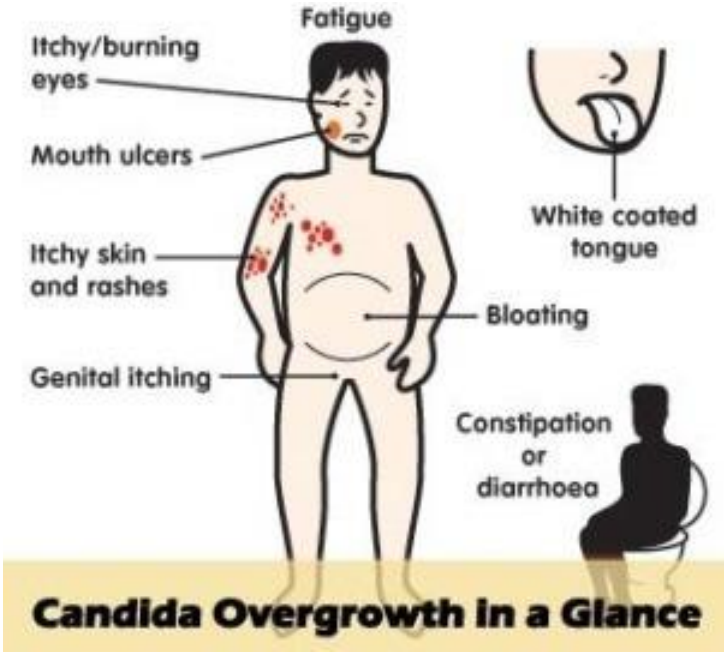
- Keep skin dry and clean, and practice good oral hygiene.
- Avoid excessive sugar intake, which can promote Candida overgrowth.
- Use antifungal medications like fluconazole, itraconazole, or topical antifungals for treatment of infections.

CERCOSPORA



PUCCINIA





ALGAE UNIT 3
Q. Notes on Algae- occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves, outline classification – **Essay question 8 marks**

1. Occurrence:

- **Habitat**: Algae are found in a wide range of aquatic environments, including freshwater, marine, and brackish water. They can also be found in moist terrestrial environments, such as soil, rocks, and tree bark. Some algae live in symbiotic relationships with other organisms, like lichens (algae + fungi).

2. Thallus Organization:

- **Definition**: The thallus is the body of the algae, which can vary widely in form and complexity.
- **Forms**:
    - **Unicellular**: Single-celled organisms, like *Chlamydomonas*.
    - **Colonial**: Groups of similar cells living together, like *Volvox*.
    - **Filamentous**: Thread-like structures made up of chains of cells, like *Spirogyra*.
    - **Multicellular**: Complex forms, ranging from simple sheets to large, plant-like structures, like kelp (*Macrocystis*).

3. Algae Cell Ultra-Structure:

- **Eukaryotic Cells**: Algae cells are eukaryotic, meaning they have a true nucleus and membrane-bound organelles.
- **Key Components**:
    - **Nucleus**: Contains genetic material (DNA).
    - **Chloroplasts**: photosynthesis occurs and contain pigments like chlorophyll.
    - **Mitochondria**: Produce energy for the cell.
    - **Endoplasmic Reticulum and Golgi Apparatus**: Involved in protein synthesis and transport.
    - **Cell Wall**: Often made of cellulose, silica, or other polysaccharides, providing structure and protection.

4. Pigments:

- **Chlorophylls**: The primary pigments for photosynthesis, mainly chlorophyll **a** and **b** in green algae, **c** in brown algae, and **d** in red algae.
- **Carotenoids**: Accessory pigments that protect chlorophyll from damage and capture additional light energy (e.g., beta-carotene, fucoxanthin in brown algae).
- **Phycobilins**: Pigments found in red algae and cyanobacteria, such as phycoerythrin (red) and phycocyanin (blue).

5. Flagella:

- **Function**: Flagella are whip-like structures that help in movement.
- **Types**:
    - **Uniflagellate**: Single flagellum (e.g., *Chlamydomonas*).
    - **Biflagellate**: Two flagella (e.g., *Euglena*).
    - **Multiflagellate**: Multiple flagella (e.g., *Dinoflagellates*).
- Structure: Flagella are made up of microtubules arranged in a "9+2" structure (nine pairs of microtubules around two central ones).

6. Eyespot:

- **Function**: The eyespot, or stigma, is a light-sensitive organelle that helps the algae sense light direction and intensity, aiding in phototaxis (movement toward light).
- **Location**: Typically found near the base of the flagellum in motile algae like *Chlamydomonas*.

7. Food Reserves:

- **Types**:
  - **Starch**: Common in green algae.
  - **Laminarin**: Found in brown algae.
  - **Floridean Starch**: Found in red algae.
  - **Oil Droplets**: Serve as an energy reserve in some algae.

8. Outline Classification:

- Algae are classified into major groups based on their pigmentation, type of food reserve, cell wall composition, and mode of reproduction:
  - **Chlorophyta (Green Algae)**:contain by chlorophyll a and b, storing food as starch (e.g., *Spirogyra*, *Chlamydomonas*).
  - **Phaeophyta (Brown Algae)**: Contain chlorophyll c and fucoxanthin, storing food as laminarin (e.g., kelp, *Sargassum*).
  - **Rhodophyta (Red Algae)**: Contain phycoerythrin and phycocyanin, storing food as floridean starch (e.g., *Porphyra*).
  - **Chrysophyta (Golden Algae)**: Contain chlorophyll c and carotenoids, storing food as oil (e.g., diatoms).
  - **Euglenophyta**: Unicellular, containing chlorophyll a and b, with a flexible pellicle instead of a cell wall (e.g., *Euglena*).
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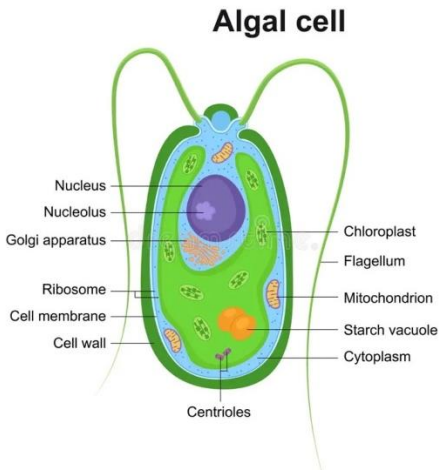
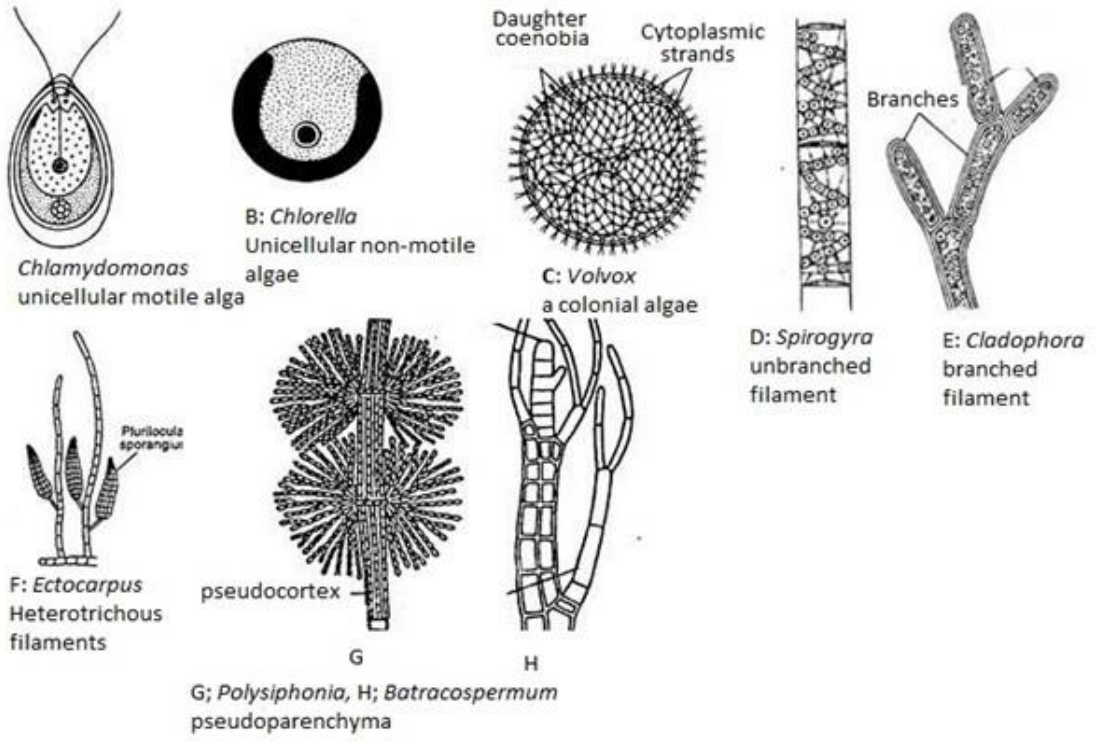




Q. Notes on Vegetative, asexual and sexual reproduction in Algae. **Essay question 8 marks**

1. Vegetative Reproduction:

- **Definition**: Vegetative reproduction involves the growth and division of the algal thallus (body) without the formation of spores or gametes. It results in offspring that are genetically identical to the parent.
- **Methods**:
  - **Fragmentation**: The most common method where the algal thallus breaks into smaller pieces, each capable of growing into a new individual. For example, in *Spirogyra*, a filament can break into fragments, and each fragment will grow into a new filament.
  - **Cell Division**: In unicellular algae like *Chlamydomonas*, the single cell divides into two identical cells, each of which becomes a new individual.

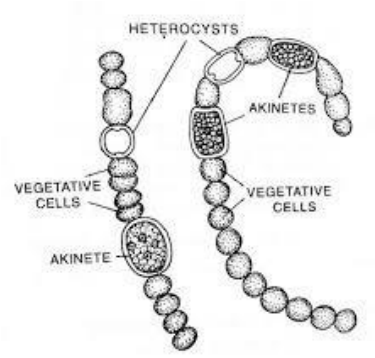
2. Asexual Reproduction:

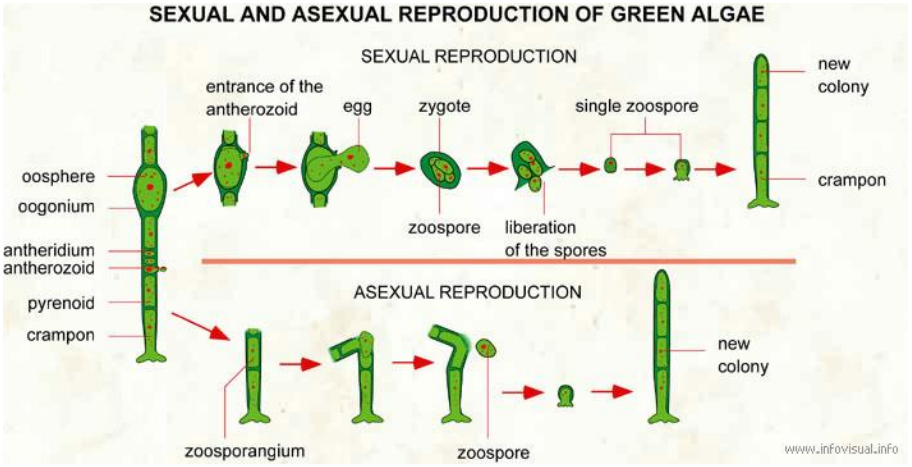
- **Definition**: Asexual reproduction involves the production of spores, which are specialized cells that can develop into new individuals without fertilization.

- **Methods**:
  - **Zoospores**: These are motile, flagellated spores produced by algae like *Chlamydomonas* and *Ulothrix*. Zoospores swim using their flagella, settle in a favorable environment, and grow into new individuals.
  - **Aplanospores**: Non-motile spores produced when conditions are unfavorable. They germinate directly into new algae when conditions improve.
  - **Autospores**: Non-motile, internal spores produced within the parent cell, typical in unicellular algae like *Chlorella*. They are released upon the disintegration of the parent cell.
  - **Binary Fission**: In unicellular algae, the cell divides into two equal halves, each forming a new organism. This is common in *Euglena* and *Chlamydomonas*.

3. Sexual Reproduction:

- **Definition**: Sexual reproduction in algae involves the fusion of two gametes (sexual cells) to form a zygote, which then develops into a new individual. This process introduces genetic diversity.
- **Types**:
  - **Isogamy**: Fusion of two similar, motile or non-motile gametes. Both gametes are of the same size and shape, as seen in *Chlamydomonas*.
  - **Anisogamy**: Fusion of two dissimilar gametes, where one is larger and non-motile (female) and the other is smaller and motile (male). Anisogamy is found in species like *Ectocarpus*.
  - **Oogamy**: A specialized form of anisogamy where a large, non-motile egg cell (female gamete) fuses with a small, motile sperm cell (male gamete). This type is seen in brown algae like *Fucus*.
- **Fertilization**:
  - **External**: Gametes are released into the water, where fertilization occurs, as seen in many marine algae.
  - **Internal**: Gametes fuse within the parent organism, a method more common in some freshwater species.





Q. Notes on Photosynthetic apparatus, and outline of Photosynthesis in Algae

1. Photosynthetic Apparatus in Algae: SPLIT ESSAY 4 MARKS

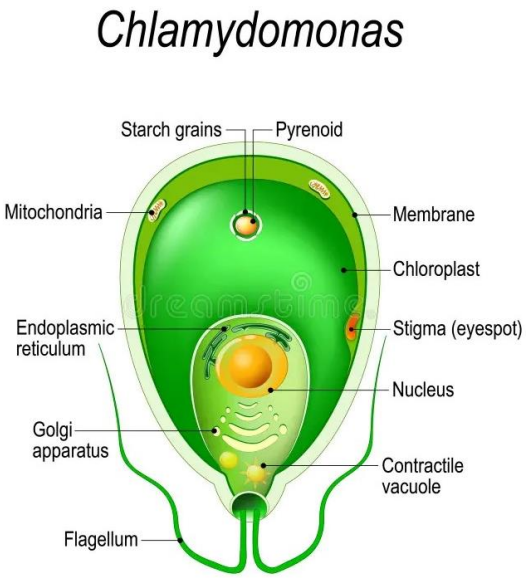
- **Chloroplasts**:
  - **Structure**: Algal cells contain chloroplasts, which are the organelles responsible for photosynthesis. Chloroplasts are typically green due to the presence of chlorophyll and have a double membrane structure.
  - **Thylakoids**: Inside the chloroplasts, there are stacks of membranes called thylakoids, where the light-dependent reactions of photosynthesis occur. In some algae, thylakoids are arranged in stacks called grana.
  - **Stroma**: The fluid-filled space surrounding the thylakoids is called the stroma, where the light-independent reactions (Calvin cycle) take place.
- **Pigments**:
  - **Chlorophylls**: The primary pigments involved in capturing light energy. Chlorophyll **a** is universal in all algae, while other forms (chlorophyll **b**, **c**, **d**) vary among different algal groups.
  - **Carotenoids**: Accessory pigments, such as carotene and xanthophyll, that assist in capturing light energy and protecting chlorophyll from damage.
  - **Phycobilins**: Found in red algae and cyanobacteria, these pigments (like phycoerythrin and phycocyanin) capture light energy in wavelengths that chlorophyll cannot absorb.

- **Photosystems**:
    - **Photosystem I (PSI)** and **Photosystem II (PSII)**: These are the complexes of pigments and proteins embedded in the thylakoid membranes that work together to capture light energy and convert it into chemical energy.

2. Outline of Photosynthesis in Algae: SPLIT ESSAY 4 MARKS

Photosynthesis in algae is similar to that in higher plants, involving two main stages: light-dependent reactions and light-independent reactions.

- **Light-Dependent Reactions (Occurs in Thylakoid Membranes)**:
    1. **Light Absorption**: Light energy is absorbed by chlorophyll and other pigments in the photosystems.
    2. **Water Splitting**: In PSII, light energy splits water molecules into oxygen, protons, and electrons (a process called photolysis). Oxygen is released as a byproduct.
    3. **Electron Transport Chain**: The energized electrons move through the electron transport chain (ETC) from PSII to PSI, releasing energy that is used to pump protons into the thylakoid lumen, creating a proton gradient.
    4. **ATP Synthesis**: The proton gradient drives the synthesis of ATP (energy currency) through a process called chemiosmosis.
    5. **NADPH Formation**: Electrons from PSI are used to reduce NADP+ to NADPH, another energy-rich molecule needed for the next stage of photosynthesis.
- **Light-Independent Reactions (Calvin Cycle, Occurs in Stroma)**:
    1. **Carbon Fixation**: The enzyme RuBisCO captures carbon dioxide (CO_2) from the atmosphere and incorporates it into a 5-carbon sugar (RuBP), forming a 6-carbon compound that quickly splits into two 3-carbon molecules (3-PGA).
    2. **Reduction Phase**: ATP and NADPH produced in the light-dependent reactions are used to convert 3-PGA into G3P (a 3-carbon sugar).
    3. **Regeneration of RuBP**: Some G3P molecules are used to regenerate RuBP, enabling the cycle to continue. Others may be used to form glucose and other carbohydrates.
    4. **Glucose Formation**: The ultimate product of the Calvin cycle is glucose, which the algae use for energy and growth.



Unit 4 IMPORTANCE OF ALGAE

Q. Importance of Algae in Agriculture, Industry, Environment, and Food

Algae, a diverse group of photosynthetic organisms. They play a important role in agriculture, industry, environment, and food.

1. Importance of Algae in Agriculture

Biofertilizers:

Algae, particularly blue-green algae (cyanobacteria) like *Anabaena* and *Nostoc*, fix atmospheric nitrogen, enriching the soil and promoting plant growth. This reduces the need for chemical fertilizers.

Soil Conditioner:

Algae improve soil structure and water retention. The addition of algal biomass to soil can enhance microbial activity and nutrient availability.

Animal Feed:

Algae, such as spirulina, are used as a supplement in animal feed due to their high protein and nutrient content.

2. Importance of Algae in Industry

Biofuel Production:

Algae are a source for biofuels such as biodiesel, bioethanol, and biogas. They have a high lipid content and fast growth rates, making them efficient producers of renewable energy.**Example**: Microalgae like *Chlorella* areused to produce biodiesel.

Pharmaceuticals and Cosmetics:

Algae produce bioactive compounds used in pharmaceuticals and cosmetics. These include antioxidants, vitamins, and anti-inflammatory substances.

Example: The red algae *Porphyra* is used to extract carrageenan, which is used in cosmetics and pharmaceuticals as a thickening agent.

Bioplastics:

- Algae are a source of bioplastics, which are more sustainable and environmentally friendly compared to conventional plastics.
- **Example**: Algal-based polylactic acid (PLA) is used to produce biodegradable plastics.

3. Importance of Algae in Environment

Carbon Sequestration:

- Algae play a crucial role in carbon sequestration, absorbing CO2 during photosynthesis and mitigating climate change. They are considered for large-scale projects to capture atmospheric CO2.

Wastewater Treatment:

- Algae are used in wastewater treatment to remove pollutants, including heavy metals, nitrates, and phosphates. They purify water while producing biomass that can be used for various purposes.
- **Example**: *Chlorella* and *Scenedesmus* .

Ecosystem Restoration:

- Algae contribute to the restoration of aquatic ecosystems by providing oxygen through photosynthesis and serving as a primary food source for aquatic organisms.

4. Importance of Algae in Food

Nutritional Supplements:

- Algae are rich in proteins, vitamins, minerals, and essential fatty acids. They are used as dietary supplements to enhance nutrition.
- **Example**: Spirulina and chlorella.

Food Additives:

- Algae are used as thickeners, stabilizers, and emulsifiers in various food products. Algal extracts like agar, alginate, and carrageenan are widely used in the food industry.
- **Example**: Agar, extracted from red algae, is used as a gelatin substitute in desserts and as a solidifying agent in microbiological media.

Functional Foods:

- Algae are incorporated into functional foods that provide health benefits beyond basic nutrition. They contain bioactive compounds that can improve health and prevent diseases.
- **Example**: Nori, a type of red algae, is used to wrap sushi and is valued for its high vitamin and mineral content.

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Q. NOTES ON ALGAL CULTURES

Algal cultures are essential for various applications, including biofuel production, nutritional supplements, and wastewater treatment. Cultivation methods vary based on the scale, purpose, and environmental conditions. Here's an overview of different algal culture methods, including indoor, outdoor, open batch, continuous, and fed-batch systems.

Indoor Algal Cultures SPLIT ESSAY 4 MARKS

Algae are grown in controlled environments, such as laboratories , bioreactors, photobioreactors, or enclosed tanks. It has Control over light, temperature, CO2, and nutrient levels.

Vertical Growth

Another method for growing algae is a vertical growth or closed loop production system. In Vertical growing algae is grown in clear, plastic bags which allows them to be exposed to sunlight. These bags are stacked high and protected from the nature with a cover. Unlike the open pond method the algae is not exposed to contamination

Photobioreactors (PBR)

Algae can also be grown in a photobioreactor (PBR). A PBR is a bioreactor which incorporates a light source.
A PBR can operate in "batch mode". It is also possible to grow and harvest continuously. e. The grower provides sterilized water, nutrients, air, and carbon dioxide at the correct rates. This allows the reactor to operate for long periods. An advantage is that algae that grows in the "log phase" is generally of higher nutrient content than old algae

Advantages:

- Precise control over growth conditions.
- Reduced risk of contamination.
- Suitable for high-value algal products.

Disadvantages:

- Higher initial and operational costs.
- Limited scalability compared to outdoor systems.

Example:

- Cultivation of microalgae like *Chlorella* and *Spirulina* in photobioreactors for nutritional supplements.

2. Outdoor Algal Cultures SPLIT ESSAY 4 MARKS

- Algae are cultivated in natural or semi-controlled environments, such as ponds, raceways, or open tanks.
- Utilization of natural sunlight.
- Less control over environmental factors compared to indoor systems.

Advantages:

- Lower operational costs.
- Large-scale production potential.
- Utilization of natural resources (e.g., sunlight, rainwater).

Disadvantages:

- Higher risk of contamination.
- Variable weather conditions can affect growth.
- Less control over temperature and nutrient levels.

Example:

- Cultivation of *Nannochloropsis* in open ponds for biofuel production.

3. Open Batch Culture

- Algae are grown in a single batch within a system (e.g., pond, tank).
- Harvested once the desired growth stage or biomass concentration is reached.
- Nutrients are supplied at the start and not replenished.

Open-Pond Growing

It easiest processes to grow algae. This is the most natural way to grow algae for the purpose of biodiesel production. In this method, algae is grown on open ponds, in very warm and sunny parts. This is the simplest form of production,

Advantages:

- Simple and easy to implement.
- Suitable for small-scale production.

Disadvantages:

- Limited productivity due to depletion of nutrients.
- Risk of contamination increases over time.

Example:

- Cultivation of *Scenedesmus* in a small pond for research purposes.

4. Continuous Culture

- Algae are continuously harvested while fresh nutrients are added to maintain constant growth conditions.

- Steady-state condition is maintained, balancing biomass removal and nutrient supply.
- Conducted in closed or semi-closed systems.

Advantages:

- Consistent and high productivity.
- Better control over growth conditions.
- Suitable for industrial-scale production.

Disadvantages:

- More complex operation and monitoring.
- Initial setup cost is higher.

Example:

- Continuous cultivation of *Dunaliella salina* in photobioreactors for consistent production of beta-carotene.

5. Fed-Batch Culture

- A hybrid approach combining batch and continuous cultures.
- Initial batch culture is started, and nutrients are added periodically (fed) to sustain growth without complete medium replacement.
- Allows control over nutrient concentration and growth rate.

Advantages:

- High productivity with controlled nutrient supply.
- Reduced risk of nutrient limitation and inhibition.
- Flexible and adaptable to various scales.

Disadvantages:

- Requires careful monitoring and control of feeding rates.
- More complex than simple batch culture.

Example:

- Fed-batch cultivation of *Haematococcus pluvialis* for enhanced astaxanthin production.

Applications of algal cultures

1. **Biofuel Production:**
    - Large-scale cultivation of algae for biofuel production (e.g., biodiesel from microalgae like Nannochloropsis).
2. **Nutritional Supplements:**
    - Production of Spirulina and Chlorella for use as dietary supplements and functional foods.
3. **Wastewater Treatment:**
    - Utilizing algae to treat wastewater by removing nutrients and contaminants.
4. **Animal Feed:**
    - Cultivation of algae for use as a high-protein feed supplement in aquaculture and livestock farming.

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Q. Notes on Culture Media and Growth Parameters for Algal Cultivation with Reference to Spirulina. Essay question 8 marks

Spirulina (Arthrospira platensis) is a cyanobacterium known for its high nutritional value and various applications in food, feed, and pharmaceuticals.

Culture Media for Spirulina

1. Standard Media:

- **Zarrouk's Medium:**
  - **Composition**: Sodium bicarbonate , sodium nitrate , potassium sulfate , sodium chloride , magnesium sulfate , calcium chloride , iron sulfate , and trace elements.
  - Provides all necessary nutrients for optimal growth.

2. Modified Media:

- **BG-11 Medium:**
  - **Composition**: Includes similar components to Zarrouk's medium but with different concentrations.
  - Flexibility to adapt to specific growth conditions.

Growth Parameters for Spirulina Cultivation

1. Light:

- **Intensity**: Spirulina requires moderate to high light intensity for optimal photosynthesis. Light intensity of 2000 to 6000 lux is generally effective.
- **Photoperiod**: Continuous light can enhance growth rates, but a 12:12 light-dark cycle is often used to balance growth and energy consumption.

2. Temperature:

- **Optimal Range**: Spirulina thrives in warm temperatures, typically between 30°C to 35°C.
- **Effects**: Growth rates significantly decrease below 20°C and above 38°C. Proper temperature control is crucial for maintaining high productivity.

3. pH:

- **Optimal Range**: Spirulina grows best in alkaline conditions with a pH range of 9 to 11.

4. Nutrients:

- **Nitrogen**: Essential for protein synthesis. Sodium nitrate ($NaNO_3$) is commonly used in culture media.
- **Phosphorus**: Important for energy transfer and nucleic acid synthesis. Provided as potassium phosphate (K_2HPO_4).
- **Micronutrients**: Iron, magnesium, calcium, and trace elements are crucial for various metabolic processes.
- **Carbon Source**: Sodium bicarbonate ($NaHCO_3$) is used as a carbon source, maintaining the required alkalinity for Spirulina growth.
-

5. Aeration:

- **Importance**: Continuous aeration ensures adequate oxygen supply and efficient mixing of nutrients, preventing the settling of cells.
- Aeration can be achieved using air pumps, spargers, or mechanical agitation.

6. Salinity:

- **Tolerance**: Spirulina can tolerate a wide range of salinity, but optimal growth is observed in low to moderate salinity levels (0.1% to 0.2% NaCl).
- Depending on the water source and specific growth requirements, salinity levels may need to be adjusted.

Applications of Spirulina

- **Nutritional Supplements**: Rich in proteins, vitamins, and antioxidants.
- **Animal Feed**: Used as a supplement in aquaculture and livestock feed.
- **Pharmaceuticals**: Source of bioactive compounds with potential health benefits.
- **Wastewater Treatment**: Can be used in bioremediation to remove contaminants from wastewater.

UNIT 5 PROTOZOA

Q. Explain General characteristics of protozoa with special reference to Amoeba, Paramecium. ESSAY QUESTION – 8 MARKS

General Characteristics of Protozoa:

Protozoa are single-celled, eukaryotic organisms that are often classified as protists. They can be free-living or parasitic and are found in various aquatic and terrestrial environments.

Cell Structure:

- **Eukaryotic**: Protozoa have a well-defined nucleus and membrane-bound organelles like mitochondria, the endoplasmic reticulum, and Golgi apparatus.
- **Plasma Membrane**: The cell is enclosed by a plasma membrane, which is covered by a protective pellicle.

Locomotion: Protozoa move using different structures:

- **Flagella**: Long, whip-like structures used for movement (e.g., *Trypanosoma*).
- **Cilia**: Short, hair-like projections that beat rhythmically for movement (e.g., *Paramecium*).

- **Pseudopodia**: Temporary extensions of the cytoplasm used for movement and feeding (e.g., *Amoeba*).

Nutrition: Protozoa exhibit various modes of nutrition:

- **Holozoic (Phagocytosis)**: Engulfing and ingesting food particles.as seen in *Amoeba*.
- **Saprotrophic**: Absorbing dissolved nutrients from the environment.
- **Parasitic**: Feeding on the host's body fluids or cells.

Reproduction:

- **Asexual Reproduction**: it includes binary fission (simple cell division) and budding.
- **Sexual Reproduction**: it includes processes like conjugation.

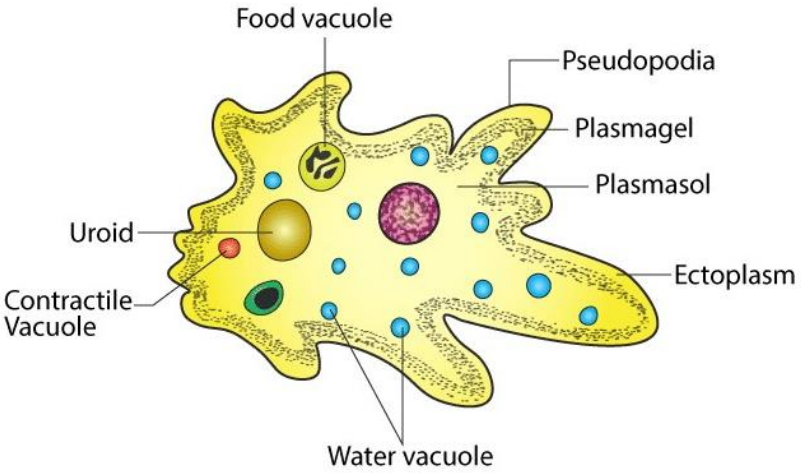
AMOEBA

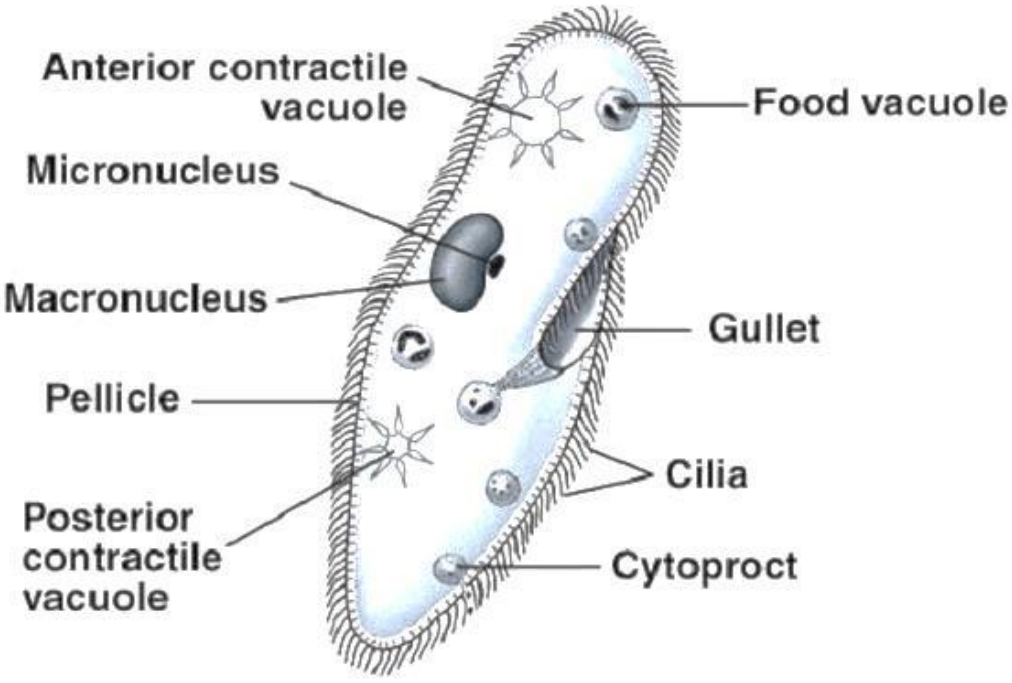
- *Amoeba* is a unicellular organism that moves and feeds using pseudopodia .
- The cell body is flexible, with no fixed shape.
- The nucleus is large and centrally located.
  - **Locomotion**:
- *Amoeba* moves by extending pseudopodia. It also called **amoeboid movement**.
  - **Feeding**:
- *Amoeba* captures food particles like bacteria by surrounding them with its pseudopodia. This process is known as **phagocytosis**.
  - **Reproduction**:
- *Amoeba* reproduces asexually through **binary fission**.

PARAMECIUM:

- *Paramecium* is a slipper-shaped unicellular organism covered with rows of cilia.
- It has a well-defined **oral groove** leading to a gullet, where food particles are ingested.
- It contains two types of nuclei: a large **macronucleus** (controls everyday functions) and one or more smaller **micronuclei** (involved in reproduction).
  - **Locomotion**:
- *Paramecium* moves by beating its cilia in a coordinated manner, which propels it forward in a spiral motion.
  - **Feeding**:

- *Paramecium* uses its cilia to sweep food particles, such as bacteria and small algae, into its oral groove, leading to the formation of food vacuoles where digestion takes place.
  - **Reproduction**:
- *Paramecium* can reproduce asexually through **binary fission**.
- It also undergoes **conjugation**, a form of sexual reproduction where two *Paramecia* exchange genetic material via their micronuclei, followed by cell division.





Q. Pathogenic Protozoa- Plasmodium, Leishmania and Giardia

Q. PLASMODIUM - SPLIT ESSAY 4 MARKS

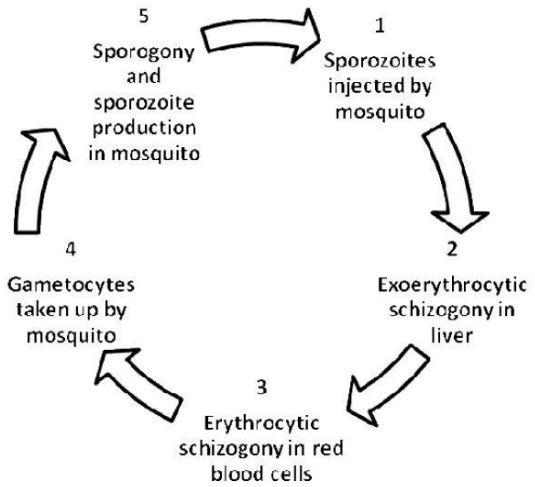
Plasmodium is the protozoan responsible for malaria. There are several species of *Plasmodium* that infect humans, including *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, and *P. knowlesi*.

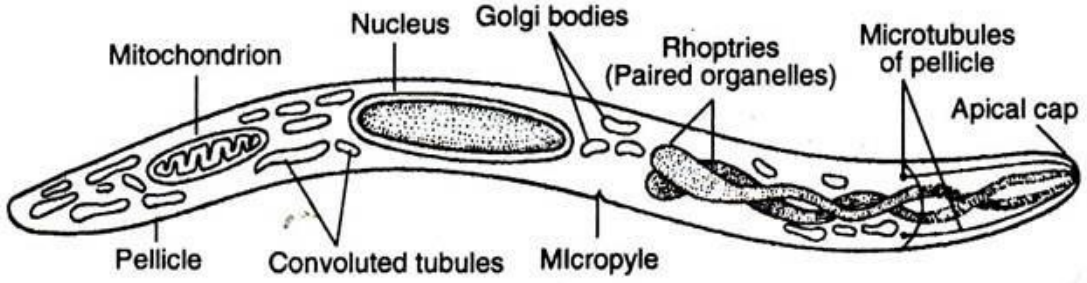
Vector: The disease is transmitted through the bite of infected female *Anopheles* mosquitoes.

Life Cycle:*Plasmodium* has a complex life cycle involving two hosts: humans and mosquitoes.

- **In the mosquito**: The sexual phase (sporogony) occurs in the mosquito's gut, where gametocytes (from human blood) fuse to form a zygote, which develops into sporozoites. These sporozoites migrate to the mosquito's salivary glands.
- **In humans**: When the mosquito bites a human, sporozoites enter the bloodstream and travel to the liver, where they multiply asexually (exo-erythrocytic cycle). The parasites then enter red blood cells (erythrocytic cycle) and multiply further, leading to the symptoms of malaria.

- **Symptoms of Malaria**:
  - Common symptoms include fever, chills, sweating, headache, nausea, and vomiting.
  - *P. falciparum* can cause severe complications like cerebral malaria, anemia, and organ failure, making it the most dangerous species.
- **Treatment**:
  - Antimalarial drugs such as chloroquine, artemisinin-based combination therapies (ACTs), and others.





PLASMODIUM

Q. LEISHMANIA

Leishmania is the protozoan responsible for leishmaniasis, a disease that affects the skin, mucous membranes, and internal organs. The disease is caused by several species, including *L. donovani*, *L. tropica*, and *L. braziliensis*.

Vector: The disease is transmitted by the bite of infected female sandflies, of the genus *Phlebotomus* or *Lutzomyia*.

- **Forms of Leishmaniasis**:
  - **Cutaneous Leishmaniasis**: Causes skin ulcers and sores. It is the most common form and is often self-healing, though it can leave scars.
  - **Mucocutaneous Leishmaniasis**: Affects the mucous membranes of the nose, mouth, and throat, leading to severe disfigurement.
  - **Visceral Leishmaniasis (Kala-azar)**: The most severe form, affecting internal organs like the liver, spleen, and bone marrow. Symptoms include fever, weight loss, anemia, and swelling of the liver and spleen. If untreated, it can be fatal.
- **Life Cycle**:
  - **In the sandfly**: The promastigote (infective) form develops in the sandfly's gut and is transmitted to humans when the sandfly bites.
  - **In humans**: Once in the human host, promastigotes are phagocytosed by macrophages and transform into the amastigote form, which multiplies within these immune cells. The amastigotes can spread to other tissues, leading to the various forms of the disease.
- **Treatment**:
  - Treatment depends on the type of leishmaniasis and can include antimonial compounds, amphotericin B, and miltefosine.
  - Preventive measures focus on avoiding sandfly bites.

3. Giardia - SPLIT ESSAY 4 MARKS

Giardia is a protozoan parasite that causes giardiasis, a common intestinal infection. The most common species infecting humans is *Giardia lamblia* (also known as *Giardia intestinalis* or *Giardia duodenalis*).

Transmission: The parasite is typically transmitted through ingestion of contaminated water or food, or via the fecal-oral route.

Life Cycle:

- *Giardia* has two main stages in its life cycle: the trophozoite (active) stage and the cyst (dormant) stage.
- **Cyst Stage**: The cysts are the infectious form and are highly resistant to environmental conditions. They are excreted in the feces of an infected host and can survive in water or food for long periods.
- **Trophozoite Stage**: Once ingested, the cysts reach the small intestine, where they excyst and release trophozoites. The trophozoites attach to the intestinal lining and multiply, causing symptoms.

Symptoms of Giardiasis:

- Symptoms include diarrhea, abdominal cramps, bloating, nausea, and fatigue.

Treatment:

- Giardiasis is treated with antiprotozoal medications such as metronidazole, tinidazole, or nitazoxanide.

Preventing

- It involves ensuring safe drinking water, practicing good hygiene, and avoiding food and water that may be contaminated.

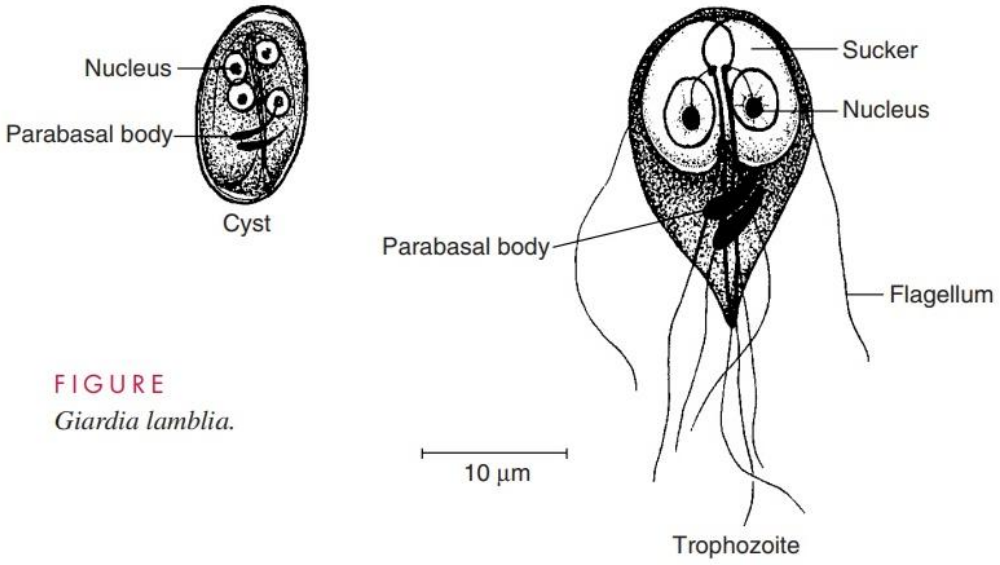
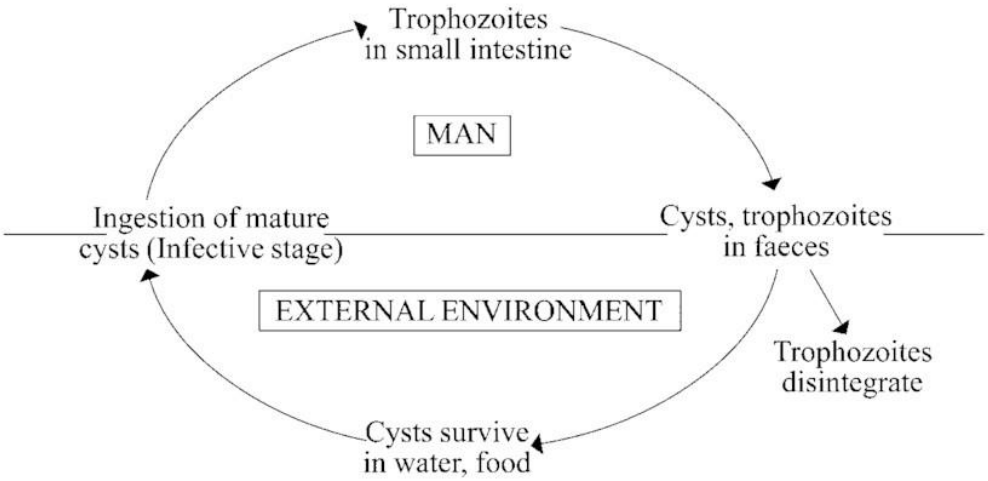


FIGURE
Giardia lamblia.



Q.Explain the Importance of protozoa (in waste management, soil fertility, industry and scientific study)

Protozoa play important roles in various ecosystems and human activities. Some of them are :

1. Importance in Waste Management:

- **Role in Decomposition**:
  - Protozoa help in decomposition of organic matter in sewage and wastewater treatment processes. They feed on bacteria and other microorganisms, helping to reduce the amount of organic waste and prevent the build up of harmful bacteria.
- **Bioremediation**:
  - Some protozoa used to remove or neutralize pollutants from contaminated environments. By consuming bacteria that degrade toxic substances, protozoa help in cleaning up oil spills, heavy metals, and other pollutants.

2. Importance in Soil Fertility:

- **Nutrient Cycling**:
  - Protozoa play a vital role in soil ecosystems by regulating bacterial populations. They feed on bacteria and release nutrients such as nitrogen and phosphorus back into the soil, making them available for plant uptake. This process enhances soil fertility and promotes healthy plant growth.
- **Soil Structure**:

- By feeding on bacteria, protozoa help maintain a balanced microbial community in the soil. This balance is essential for the formation of soil aggregates, which improve soil structure, aeration, and water retention.

3. Importance in Industry:

- **Biofuel Production**:
  - Some protozoa, like *Euglena* can produce lipids and other bioactive compounds that can be converted into biofuels, offering a renewable energy source.
- **Pharmaceuticals**:
  - Protozoa produce various bioactive compounds that have potential pharmaceutical applications. For example, *Tetrahymena* is used in research to study cell biology and drug effects. Additionally, some protozoa are involved in the synthesis of valuable enzymes and antibiotics.
- **Food Industry**:
  - Protozoa like *Cryptosporidium* and *Giardia* are of concern in food safety, as they can contaminate water and food sources. Understanding their biology and ecology helps in developing better strategies for food and water treatment, ensuring safety in the food industry.

4. Importance in Scientific Study:

- **Model Organisms**:
  - Protozoa such as *Paramecium* and *Tetrahymena* serve as model organisms in scientific research. They are used to study fundamental biological processes like cell division, gene expression, and cellular motility, providing insights that are applicable to higher organisms, including humans.
- **Evolutionary Studies**:
  - Protozoa are studied to understand the evolution of eukaryotic cells. Their simple structure and diverse lifestyles offer clues about the early evolution of life and the development of complex multicellular organisms.
- **Medical Research**:
  - Pathogenic protozoa like *Plasmodium* (malaria) and *Trypanosoma* (sleeping sickness) are extensively studied to develop treatments and vaccines. Research on these organisms helps in understanding host-parasite interactions and developing strategies to combat protozoan diseases.

Q.Write notes on Culturing protozoans from natural sources-Hay water, pond water, Chalkley's solution. (Essay Question- 8 marks)

Some of the methods of Culturing protozoans from natural sources are :

1. Hay Water Culture

- **Preparation**:
  - Hay water is prepared by soaking dried hay (or grass) in water. 100 grams of hay is added to 1 liter of distilled water.
  - The mixture is left to steep for several days to a week. This process allows the release of organic matter and nutrients from the hay, which supports the growth of protozoans and other microorganisms.
- **Culturing Process**:
  - **Aging**: After soaking, the solution is allowed to sit at room temperature for a few days. During this period, microorganisms from the hay, including protozoans, will proliferate in the nutrient-rich environment.
  - **Isolation**: A small sample of the hay water is then examined under a microscope. Protozoans can be isolated by transferring a small amount of the sample to a petri dish or another suitable medium.
- **Use**:
  - Hay water culture is a simple and cost-effective way to culture a variety of protozoans.

2. Pond Water Culture

- **Preparation**:
  - Pond water is collected from natural ponds, lakes, or any stagnant water body. Pond water is rich in organic material and provides a natural habitat for protozoans.
  - The water sample is used directly without additional preparation, as it already contains a diverse microbial community.
- **Culturing Process**:
  - **Direct Observation**: A small sample of pond water is observed under a microscope to identify protozoans. Different types of protozoans can be isolated using micropipettes or other techniques.
  - **Enrichment**: Sometimes, additional nutrients or growth media may be added to the pond water to enhance the growth of specific protozoan species.
  - **Isolation**: Protozoans can be isolated by transferring them to culture dishes with suitable media for further study.
- **Use**:

- Pond water is a natural source for studying a variety of protozoan species. It is useful for ecological studies, biodiversity research, and educational purposes.

3. Chalkley's Solution

- **Preparation**:
  - **Ingredients**: Chalkley's solution is a specialized medium used for culturing protozoans .It has the following includes:
    - **Distilled water**
    - **Peptone**
    - **Yeast extract**
    - **Calcium carbonate** (to buffer the solution and provide calcium)
  - **Procedure**: Ingredients are mixed and the solution is then sterilized to prevent contamination.
- **Culturing Process**:
  - **Inoculation**: A small amount of natural water sample such as from a pond or hay water) is added to the prepared Chalkley's solution.
  - **Incubation**: The culture is incubated at a temperature of 25-30°C to promote the growth of protozoans.
  - **Observation**: After incubation, the culture is observed under a microscope. Protozoans can be isolated and studied using various techniques.
- **Use**:
  - Chalkley's solution provides a controlled environment for the growth of protozoans and is useful for laboratory studies where specific conditions are required.

Q. Notes on Haplobiontic (Nemalion), Haplontic (Chlamydomonas), Diplontic (Cladophora), Diplobiontic (Polysiphonia) and Diplohaplontic (Cladophora) life cycles.

Here's an overview of various life cycles in algae and related organisms, including haplobiontic, haplontic, diplontic, diplobiontic, and diplohaplontic types:

1. Haplobiontic Life Cycle (e.g., *Nemalion*)

- **Definition**: In a haplobiontic life cycle, the organism alternates between a haploid (n) and a diploid (2n) phase, but only one phase is multicellular.
- **Organism Example**: *Nemalion*, a red alga.

- **Life Cycle**:
    - **Haploid Phase**: The dominant phase is the haploid phase. The haploid individual (gametophyte) is multicellular and reproduces asexually by producing haploid spores.
    - **Diploid Phase**: The diploid phase is short-lived and typically involves the formation of a zygote that immediately undergoes meiosis to produce haploid spores.
    - **Reproduction**: The haploid phase produces gametes, which fuse to form a diploid zygote. The zygote quickly undergoes meiosis, resulting in the return to the haploid phase.

2. Haplontic Life Cycle (e.g., *Chlamydomonas*)

- **Definition**: In a haplontic life cycle, the organism is predominantly haploid, and the diploid phase is brief and occurs only during the formation of the zygote.
- **Organism Example**: *Chlamydomonas*, a green alga.
- **Life Cycle**:
    - **Haploid Phase**: The dominant phase is the haploid phase. The organism is haploid throughout its life cycle and reproduces asexually by mitosis.
    - **Diploid Phase**: When two haploid gametes fuse, they form a diploid zygote. The diploid zygote undergoes meiosis to produce haploid spores or cells.
    - **Reproduction**: Asexual reproduction occurs through mitosis, producing haploid cells. Sexual reproduction occurs when haploid gametes fuse to form a diploid zygote, which then undergoes meiosis to return to the haploid state.

3. Diplontic Life Cycle (e.g., *Cladophora*)

- **Definition**: In a diplontic life cycle, the organism is predominantly diploid, and the haploid phase is reduced to the formation of gametes.
- **Organism Example**: *Cladophora*, a green alga.
- **Life Cycle**:
    - **Diploid Phase**: The dominant phase is the diploid phase. The organism is diploid throughout most of its life cycle and reproduces asexually by mitosis.
    - **Haploid Phase**: The haploid phase is limited to the production of gametes. Gametes are produced by meiosis and fuse to form a diploid zygote.

- **Reproduction**: The diploid individual produces gametes through meiosis. Gametes fuse to form a diploid zygote, which develops into a new diploid organism.

4. Diplobiontic Life Cycle (e.g., *Polysiphonia*)

- **Definition**: In a diplobiontic life cycle, there is an alternation between two multicellular stages: a haploid (gametophyte) and a diploid (sporophyte) stage.
- **Organism Example**: *Polysiphonia*, a red alga.
- **Life Cycle**:
  - **Haploid Phase**: The gametophyte is multicellular and produces gametes (sperm and eggs) through mitosis.
  - **Diploid Phase**: The sporophyte is also multicellular and produces spores through meiosis. The spores develop into gametophytes.
  - **Reproduction**: The haploid gametophyte produces gametes that fuse to form a diploid sporophyte. The diploid sporophyte produces haploid spores through meiosis, which then grow into new gametophytes.

5. Diplohaplontic Life Cycle (e.g., *Cladophora*)

- **Definition**: In a diplohaplontic life cycle, both haploid and diploid stages are multicellular and can be prominent at different stages of the life cycle.
- **Organism Example**: *Cladophora* (note: *Cladophora* is also listed under diplontic, as some sources might use different categorizations).
- **Life Cycle**:
  - **Haploid Phase**: The gametophyte (haploid) stage is multicellular. This phase produces gametes through mitosis.
  - **Diploid Phase**: The sporophyte (diploid) stage is also multicellular and produces spores through meiosis.
  - **Reproduction**: Gametes from the haploid stage fuse to form a diploid zygote, which develops into a diploid sporophyte. The diploid sporophyte produces haploid spores through meiosis, which develop into new haploid gametophytes.

Summary:

- **Haplobiontic**: Dominant haploid phase with a short-lived diploid phase (e.g., *Nemalion*).
- **Haplontic**: Predominantly haploid with a brief diploid phase (e.g., *Chlamydomonas*).
- **Diplontic**: Predominantly diploid with a reduced haploid phase (e.g., *Cladophora*).

- **Diplobiontic**: Alternates between multicellular haploid and diploid stages (e.g., *Polysiphonia*).
- **Diplohaplontic**: Both haploid and diploid stages are multicellular and prominent (e.g., *Cladophora*).

UNIT 1

Multiple Choice Questions (MCQs)

1. **Which of the following is a common habitat for fungi?**
   a) Freshwater
   b) Soil
   c) Inside human body
   d) All of the above
   Answer: d) All of the above
2. **Which group of fungi is also known as "imperfect fungi" due to the absence of a sexual reproductive stage?**
   a) Ascomycetes
   b) Basidiomycetes
   c) Deuteromycetes
   d) Phycomycetes
   Answer: c) Deuteromycetes
3. **Which of the following is a feature of fungal cell walls?**
   a) Made of cellulose
   b) Contains chitin
   c) Lacks a cell wall
   d) Composed of phospholipids
   Answer: b) Contains chitin
4. **Heterokaryosis in fungi refers to:**
   a) The presence of multiple types of nuclei in a single cell
   b) Fusion of gametes
   c) Sexual reproduction
   d) Spore formation
   Answer: a) The presence of multiple types of nuclei in a single cell
5. **Candida albicans exhibits dimorphism, which means:**
   a) It has a unique reproductive cycle
   b) It can exist in both yeast and filamentous forms
   c) It has two types of nuclei
   d) It is found in both plants and animals
   Answer: b) It can exist in both yeast and filamentous forms

Fill in the Blanks

6. Fungi are typically heterotrophic, meaning they obtain their nutrients by _____.
   Answer: absorption
7. In Ascomycetes, sexual reproduction results in the formation of spores called _____ within a sac-like structure known as an ascus.
   Answer: ascospores
8. The process where two genetically different hyphae fuse but their nuclei remain separate is called _____.
   Answer: heterokaryosis

True or False

9. **Fungal cell walls are made primarily of cellulose, just like plant cell walls.**
   Answer: False (Fungal cell walls are made of chitin, not cellulose.)
10. **Basidiomycetes are characterized by producing their sexual spores on specialized structures called basidia.**
    Answer: True

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UNIT 2

Multiple Choice Questions (MCQs)

1. **Which of the following fungi is commonly used in the production of antibiotics such as penicillin?**
   a) Aspergillus
   b) Penicillium
   c) Candida
   d) Puccinia
   Answer: b) Penicillium
2. **Fungi play a major role in brewing by facilitating the fermentation process. Which of the following fungi is primarily used in brewing beer?**
   a) Saccharomyces cerevisiae
   b) Candida albicans
   c) Aspergillus niger
   d) Cercospora
   Answer: a) Saccharomyces cerevisiae
3. **Which of the following is an edible mushroom commonly cultivated for food production?**

a) Puccinia
b) Milky Mushroom
c) Aspergillus
d) Cercospora
Answer: b) Milky Mushroom

4. **Mycoherbicides are used in agriculture to control:**
   a) Insects
   b) Fungal pathogens
   c) Weeds
   d) Nutrient levels in soil
   Answer: c) Weeds
5. **Which of the following fungi is known to cause infection in humans and is classified as a pathogen?**
   a) Penicillium
   b) Cercospora
   c) Candida albicans
   d) White button mushroom
   Answer: c) Candida albicans

Fill in the Blanks

6. Fungi such as _____ are used to produce enzymes like amylase, which is important in the food industry.
   Answer: Aspergillus niger
7. Mycotoxins, such as aflatoxins, are toxic compounds produced by fungi like _____, which can contaminate crops and affect human and animal health.
   Answer: Aspergillus
8. The fungal pathogen _____ is responsible for causing leaf spot disease in plants like sugarcane and other crops.
   Answer: Cercospora

True or False

9. **Mycofungicides are fungi used to control fungal plant pathogens, promoting healthy crop growth.**
   Answer: True
10. **White button mushrooms (Agaricus bisporus) are one of the most commercially cultivated mushrooms worldwide.**
    Answer: True

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UNIT 3

Multiple Choice Questions (MCQs)

1. **Which of the following pigments is commonly found in green algae?**
   a) Phycoerythrin
   b) Chlorophyll a
   c) Fucoxanthin
   d) Phycocyanin
   Answer: b) Chlorophyll a
2. **Algae are primarily found in which type of habitat?**
   a) Terrestrial forests
   b) Freshwater and marine environments
   c) Deserts
   d) Underground caves
   Answer: b) Freshwater and marine environments
3. **What type of food reserve is stored in red algae?**
   a) Starch
   b) Glycogen
   c) Floridean starch
   d) Lipids
   Answer: c) Floridean starch
4. **Which structure is responsible for detecting light in some motile algae?**
   a) Pyrenoid
   b) Stigma (eyespot)
   c) Nucleus
   d) Contractile vacuole
   Answer: b) Stigma (eyespot)
5. **The process of photosynthesis in algae mainly takes place in which cellular structure?**
   a) Nucleus
   b) Mitochondria
   c) Chloroplast
   d) Ribosome
   Answer: c) Chloroplast

Fill in the Blanks

6. The thallus organization of algae can be unicellular, colonial, filamentous, or _____.
   Answer: multicellular

7. Algae such as Chlamydomonas use _____ for locomotion, which are whip-like structures that enable movement in water.
   Answer: flagella
8. In sexual reproduction, algae undergo a process where two gametes fuse to form a _____.
   Answer: zygote

True or False

9. **Algae store their food reserves in the form of lipids and starch, depending on the type of algae.**
   Answer: True
10. **Photosynthesis in algae primarily uses chlorophyll b as the major pigment, similar to higher plants.**
    Answer: False (Algae primarily use chlorophyll a as the major pigment.)

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UNIT 4

Multiple Choice Questions (MCQs)

1. **Which of the following algae is commonly used as a biofertilizer in rice cultivation?**
   a) Chlorella
   b) Spirulina
   c) Anabaena
   d) Laminaria
   Answer: c) Anabaena
2. **Which type of algal culture system allows continuous harvesting of algae while replenishing nutrients regularly?**
   a) Batch culture
   b) Fed-batch culture
   c) Continuous culture
   d) Open culture
   Answer: c) Continuous culture
3. **Spirulina is widely known for its application in which of the following industries?**
   a) Textile industry
   b) Pharmaceutical industry
   c) Biofuel industry

d) Food and dietary supplements
Answer: d) Food and dietary supplements

4. **Which parameter is most important for optimizing algal growth in culture systems?**
   a) Light intensity
   b) pH level
   c) Temperature
   d) All of the above
   Answer: d) All of the above
5. **Open pond systems for algae cultivation are commonly used because:**
   a) They have low operational costs
   b) They prevent contamination
   c) They allow for strict control of growth conditions
   d) They are only suitable for indoor environments
   Answer: a) They have low operational costs

Fill in the Blanks

6. Algae play a crucial role in the production of _____, which are used as stabilizers in the food industry (e.g., ice cream and sauces).
   Answer: hydrocolloids (like agar, alginate, and carrageenan)
7. One of the most important environmental benefits of algae is their ability to fix _____, which helps reduce greenhouse gas levels.
   Answer: carbon dioxide (CO_2)
8. _____ is a commonly used medium for algal culture, particularly for cultivating Spirulina.
   Answer: Zarrouk's medium

True or False

9. **Algal biofuels are considered a renewable energy source because algae can be grown rapidly and produce high amounts of lipids for biodiesel production.**
   Answer: True
10. **Fed-batch culture is a closed system where nutrients are added periodically to the culture but the volume remains constant.**
    Answer: True

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UNIT 5 !

Multiple Choice Questions (MCQs)

1. **Which of the following protozoa moves by the use of pseudopodia?**
   a) Paramecium
   b) Amoeba
   c) Plasmodium
   d) Giardia
   Answer: b) Amoeba
2. **Plasmodium, the causative agent of malaria, is transmitted to humans through:**
   a) Airborne spores
   b) Contaminated water
   c) Mosquito bites
   d) Direct skin contact
   Answer: c) Mosquito bites
3. **Which protozoan is known for its characteristic cilia, which aids in movement and feeding?**
   a) Amoeba
   b) Paramecium
   c) Giardia
   d) Leishmania
   Answer: b) Paramecium
4. **The Diplontic life cycle, in which the dominant phase is diploid, is found in which organism?**
   a) Cladophora
   b) Nemalion
   c) Chlamydomonas
   d) Polysiphonia
   Answer: a) Cladophora
5. **Which protozoan is responsible for causing leishmaniasis?**
   a) Plasmodium
   b) Giardia
   c) Leishmania
   d) Amoeba
   Answer: c) Leishmania

Fill in the Blanks

6. _____ is a protozoan that causes severe diarrhea and gastrointestinal distress in humans, usually from contaminated water sources.
   Answer: Giardia

7. Protozoa play an important role in waste management as they help in the _____ of organic material in sewage treatment processes.
   Answer: decomposition
8. The culture technique using _____ is commonly employed to grow protozoa from natural sources like pond water.
   Answer: Hay water

True or False

9. **Chlamydomonas exhibits a haplontic life cycle, where the main life stage is haploid.**
   Answer: True
10. **Diplobiontic organisms, such as Polysiphonia, have both diploid and haploid multicellular stages in their life cycle.**
    Answer: True