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Chapter-I Living World – Fungi

1. The study of fungus is called Mycology (Greek: Mykes – Mushroom, Logos – To study)
2. The word Fungus is derived from Latin word. Meaning – Mushroom
3. P.A. Micheli considered as founder of Mycology
4. E.J. Butler Father of Indian Mycology
5. He established Imperial Agricultural Research Institute at Pusa, Bihar
6. Later shifted to New Delhi and at present know as Indian Agricultural Research Institute (IARI)
7. He published a book “Fungi and Diseases in Plants” on Indian Plant Diseases in the year 1918.

Alexander Fleming

- Alexander Fleming discovered Penicillin in the year 1928
- For this research work he was awarded Nobel Prize in Medicine in the year 1945

Milestone in Mycology

- ❖ 1729 – P.A. Micheli – Spore culture method in fungi
- ❖ 1767 – Fontana – Fungi causes diseases in Plants
- ❖ 1873 – C.H. Blackley – Fungi causes allergy in Human beings
- ❖ 1906 – A.F. Blakesleey – Heterothallism in Fungi
- ❖ 1952 – Pontecarvo and Raper – Parasexual cycle in Fungi

General characteristics features of Fungi

1. Cell wall – The fungal cell wall is made up of polysaccharides called chitin (Polymers of N-acetyl glucosamine)
2. Hypha – Fungus are made up of thin, filamentous, branched structure is called hyphae
3. Mycelium – Many hyphae are interwoven and form a group of structure is called Mycelium
4. Septate mycelium – The fungal hyphae are interrupted with cross wall is called septate mycelium. Eg: Fusarium
5. Aseptate mycelium - The fungal hyphae are not interrupted with cross wall is called Aseptate mycelium.
6. Coenocytic mycelium – The Aseptate multinucleate fungal hyphae is called coenocytic mycelium. Eg: Albugo
7. Plectenchyma – The loosely or compactly arranged fungal mycelium is called Plectenchyma. It is two types
8. Prosenchyma – They are arranged loosely but parallel to one another
9. Pseudoparenchyma – The fungal hyphae are compactly arranged and lose their identity
10. Holocarpic – The fungal entire thallus converted into reproductive structure is called Holocarpic
11. Eucarpic – In the fungal thallus some regions only involved in Reproduction and other regions remain as Vegetative structure
12. Anamorph – The Asexual phase of the fungus is called Anamorph
13. Telomorph - The sexual phase of the fungus is called Telomorph
14. Holomorph – The sexual and asexual phase of the fungus is called Holomorph
15. Reproduction – The fungal reproduction are involved in the following three different types
 - (i) Plasmogamy – Fusion of the two Protoplasm
 - (ii) Karyogamy – Fusion of two Nuclei
 - (iii) Production of haploid spores through meiosis

Methods of Reproduction in Fungi

Asexual Reproduction methods

1. Zoospores – They are flagellated structure produced in zoosporangia. Eg: Chytrids.
2. Conidia – The spores produced on conidiophores. Eg: Aspergillus, Penicillin.
3. Oidia – The hypha divide and develop into spores called oidia. Eg: Erysiphe.
4. Fission – The vegetative cell divide into two daughter cells. Eg: Schizosaccharomycetes (Yeast)
5. Budding – A small outgrowth developed from parental cells. Eg: Saccharomycetes (Yeast)
6. Chlamydospores – Thick walled resting spores are called Chlamydospores. Eg: Fusarium.

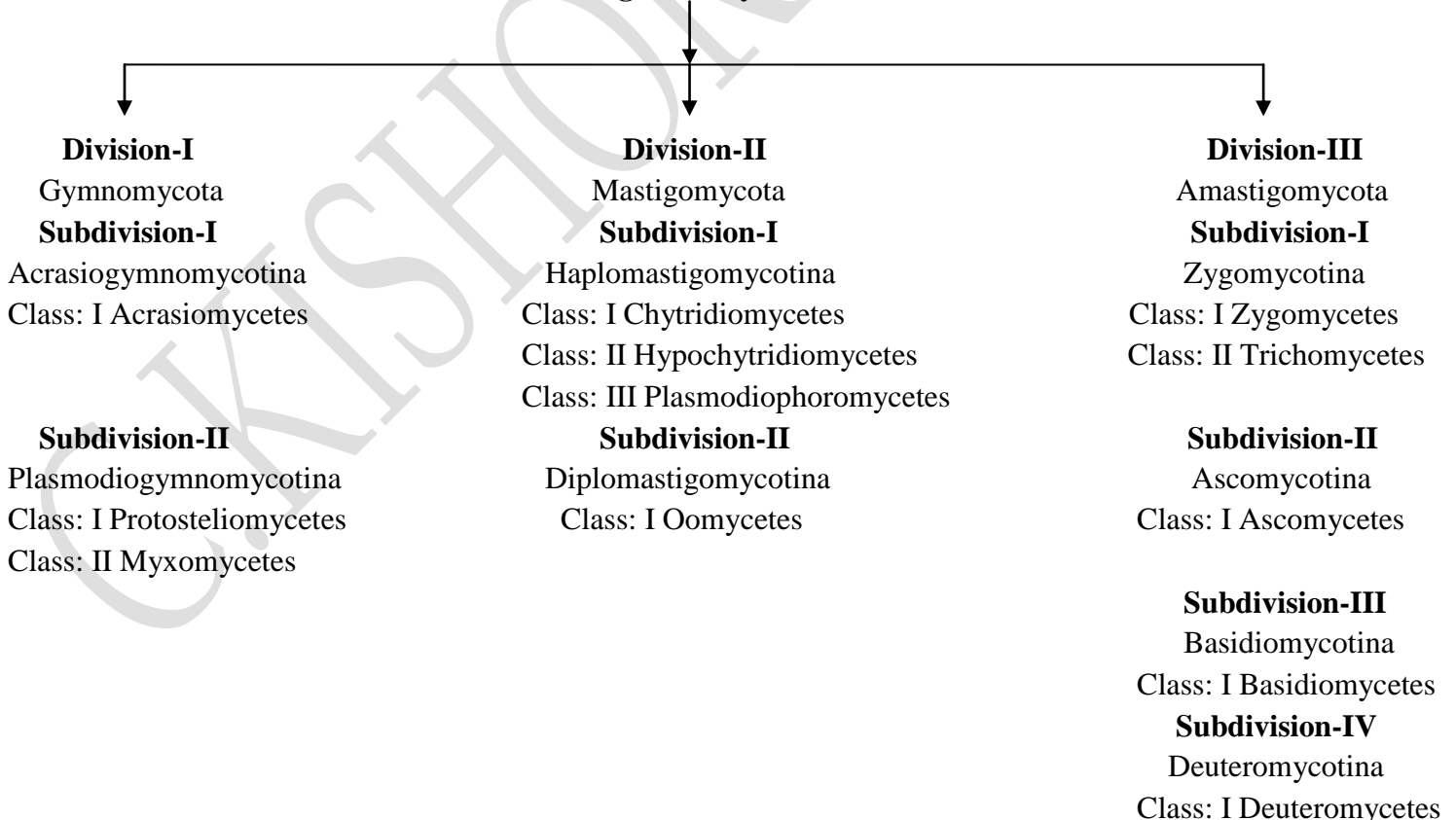
Sexual Reproduction methods

1. Planogametic copulation – Fusion of motile gamete is called Planogametic copulation. It is three different types
 - (i) Isogamy – Fusion of morphologically and physiologically similar gametes. Eg: Synchytrium.
 - (ii) Anisogamy - Fusion of morphologically or physiologically dissimilar gametes. Eg: Allomycetes.
 - (iii) Oogamy – Fusion of morphologically and physiologically dissimilar gametes. Eg: Monoblepharis.
2. Gametangial contact – During sexual reproduction a contact is established between Antheridium and Oogonium. Eg: Albugo.
3. Gametangial copulation – Fusion of gametangia to form Zygosporē. Eg: Mucor and Rhizopus.
4. Spermatization – A uninucleate Pycniospore or Micro conidium is transferred to receptive hypha. Eg: Neurospora and Puccinia.
5. Somatogamy – Fusion of two somatic cells of the hyphae. Eg: Agaricus.

Classification of Fungi

In 1979 J.Alexopoulos and Charles W.Mims proposed fungal classification in his book “Introductory Mycology” They are classified fungus in 3 division, 8 subdivision, 11 classes, 1form class and 3 form sub classes.

Kingdom: Myceteae



Characteristic features of Three Divisions

Division: I Gymnomycota

- Phagotrophic type of nutrition, Lack cell wall. Eg: Dictyostelium

Division: II Mastigomycota

- Absorption mode of nutrition, Flagellate cells are present, coenocytic mycelium. Eg: Albugo

Division: III Amastigomycota

- Unicellular and multicellular, septate mycelium, Asexual reproduction. Eg: Peziza.

Salient feature of Oomycetes (Eg: Albugo)

1. Cell wall is made up of cellulose and glucan, coenocytic mycelium
2. Zoospore with one whiplash and one tinsel type of flagellum, sexual reproduction by oogamous

Salient feature of Zygomycetes

1. Branched and coenocytic mycelium, asexual reproduction by spores
2. Sexual reproduction by fusion of gametangia and produce zygospores
3. Most of the species are saprophytic. Decaying plants and animal matters
4. Bread mold fungi Eg: Mucor and Rhizopus, Coprophilous fungi Eg: Pilobolus.

Salient feature of Ascomycetes (Eg: Peziza)

1. Ascomycetes are includes yeast, cup fungi, powdery mildew, morels
2. They are living in terrestrial and aquatic environment include marine and freshwater
3. Most of the fungus are saprophytes some are parasitic. Eg: powdery mildew – Erysiphe
4. Well branched and septate mycelium, asexual reproduction by oidia, conidia, budding.
5. Sexual reproduction by Karyogamy, a special type of ascogenous haphae is formed
6. Ascospores are produced from inside the bag like structure is called Ascus.
7. So this group of fungus are popularly known as “Sac fungi”
8. They are produce four different types of ascocarp. Such as (i). Cleistothecium (closed structure), (ii). Perithecium (flask shaped), (iii). Apothecium (Cup shaped), (iv). Pseudothecium.

Salient feature of Basidiomycetes (Eg: Agaricus)

1. Basidiomycetes includes puff balls, toad stools, bird's nest, bracket fungi
2. They are saprophytic, parasitic and terrestrial. Well developed septate mycelium with dolipore septum
3. Clamp connection are formed in dikaryotic condition.
4. Asexual reproduction by spores, oidia, conidia, budding. Sexual reproduction by Karyogamy.
5. The basidium is club shaped so this group of fungus are popularly known as “Club fungi”
6. The fruiting body is called Basidiocarp. Basidium are produced 4 basidiospores (2 are (+) strains, 2 are (-) strains)
7. Basidiospores are attached with basidium through a small stalk like structure is called Sterigmata.
8. Three different types of mycelium are produced Agaricus such as (i) Primary mycelium – Monokaryotic, (ii) Secondary mycelium – Dikaryotic, (iii) Tertiary mycelium.

Salient feature of Deuteromycetes or Fungi imperfecti

1. They are lack sexual reproduction so this group of fungus are called as Imperfect fungi
2. Mostly saprophytic, some are parasitic growing in plants and animal matters
3. Asexual reproduction takes place by oidia, conidia, budding and chlamydospores
4. Conidia are produced from a specialized structure called pycnidium, acervulus, sporodochium, and synnema
5. Parasexual cycle is takes place so it shows the genetic variation among the species.

Economic importance of Fungi

1. Food

1. Agaricus bisporus, volvariella volvaceae are the highly nutrient fungus
2. Yeast provide vitamin-B and Eremothecium ashbyii is a rich source of vitamin-B₁₂

2. Medicine

1. Fungus produce bacterial antibiotic like Penicillin – Penicillium notatum, Ergot – Claviceps purpurea

3. Industries

Fungus are very useful to produce organic acid such as

1. Citric and Gluconic acid – Aspergillus niger
2. Itaconic acid – Aspergillus terreus
3. Kojic acid – Aspergillus oryzae

4. Bakery and brewery

1. Alcohol is extracted from Saccharomyces cerevisiae (Yeast) by the process of fermentation
2. Yeast is the good source for bread and bun manufacturing

5. Production of enzymes

1. Amylase, Protease, Lactase enzymes are produced by Aspergillus oryzae and Aspergillus niger.
2. Rennet which helps in the coagulation of milk in cheese manufacturing is derived from Mucor spp.

6. Agriculture

1. Gibberellin is produced by Gibberella fujikuroi. It promotes the internodal growth in plants

7. Harmful activities

1. Amanita species are highly poisonous. It produces toxins. So it is commonly referred as “Toad stools”
2. Aspergillus, Mucor, Rhizopus and Penicillium are involved in spoilage of food materials.
3. Aspergillus flavus infects dried food and produces carcinogenic toxin called aflatoxin.

Diseases caused by Fungus

Fungal diseases in Plants

1. Blast of Paddy – Magnaporthe grisea
2. Red rot of Sugarcane – Colletotrichum falcatum
3. Anthracnose of Beans – Colletotrichum lindemuthianum
4. White rust of Crucifers – Albugo candida
5. Rust of wheat – Puccinia graminis tritici

Fungal diseases in Animals

1. Athlete's foot – Epidermophyton floccosum
2. Candidiasis – Candida albicans
3. Coccidioidomycosis – Coccidioides immitis
4. Aspergillosis – Aspergillus fumigatus

Dermatophytes

Dermatophytes are fungus which causes infection in skin. Eg: Trichophyton, Tinea, Microsporum, Epidermophyton.

Ireland (1843-1845)

Late blight of Potato – Phytophthora infestans

Bengal famine (1942-1943)

Blight of Paddy – Helminthosporium oryzae.

Rhizopus

Class: Zygomycetes
Order: Mucorales
Family: Mucoraceae
Genus: Rhizopus

Habitate

- (i) Rhizopus is a saprophytic fungus, growing on bread, lather, jelly, decaying vegetables and fruits
- (ii) It is commonly called as "Bread mold"
- (iii) Rhizopus stolonifer causes leak and soft rot of vegetables

Vegetative structure

1. The mycelium consists of aseptate, multinucleate, coenocytic mycelium.
2. Horizontally growing hyphae is called "Stolons". The cell wall is made up of chitin and chitosan
3. Stolons produce downwards Rhizoids and upwards Sporangioophores
4. The cell organelles like Mitochondria, Ribosomes and Endoplasmic reticulum are present.

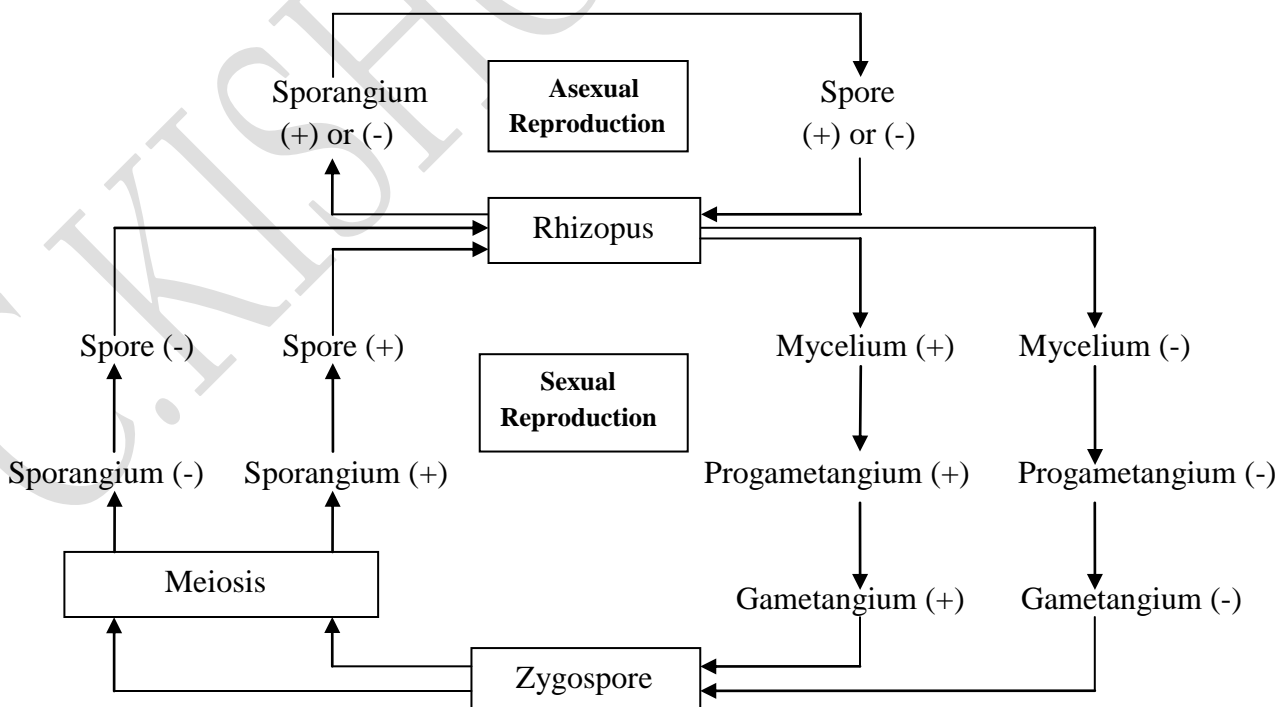
Asexual Reproduction

1. During favorable condition Stolons produce downwards Rhizoids and upwards Sporangioophores
2. Sporangioophore are unicellular, unbranched, multinucleate structure. Which bears bag like structure called Sporangium.
3. Sporangium possesses a sterile region in the centre is called Columella. Spores are produced around the columella
4. When the columella bursts, spores are dispersed.

Sexual Reproduction

1. Most of the species are Heterothallic but Rhizopus sexualis is Homothallic.
2. Physiologically dissimilar thalli (hyphae) are involved in sexual reproduction. This phenomenon is called Heterothallism.

Life cycle of Rhizopus



Agaricus

Class: Basidiomycetes
Order: Agaricales
Family: Agaricaceae
Genus: Agaricus

Habitate

- (i) Agaricus growing on wood logs, litters and humus. So it is called as saprophytic fungus
- (ii) Agaricus arvensis and Agaricus tabularis are found in ring like form so it is called as 'Fairy rings'.
- (iii) Agaricus campestris is commonly called as field mushroom. Fruit body is the visible part of the fungus.

Vegetative structure

- 1. The thallus are made up of branched structure is called hyphae. Hyphae are interwoven and form mycelium
- 2. The cell wall is made up of chitin. The cell internal organs like mitochondria, golgibodies, endoplasmic reticulum are present.

Types of mycelium

There are three different types of mycelium are seen in Agaricus

1. Primary mycelium

- 1. Primary mycelium are produced for basidiospores. It is septate, unicellular, and haploid mycelium
- 2. It is also called as monokaryotic mycelium

2. Secondary mycelium

- 1. Primary mycelium of opposite strains gives rise to secondary mycelium.
- 2. It is otherwise called as dikaryotic mycelium.
- 3. Dikaryotic mycelium develop into hyphal cords called Rhizomorphs. It is penetrate into soil and hold the fruiting body of Agaricus.

3. Tertiary mycelium

Tertiary mycelium are found in the fruiting body of basidiocarp

Asexual Reproduction

- 1. Agaricus produce chlamydospores during asexual reproduction.
- 2. During favourable condition chlamydospores germinate and produce mycelium

Sexual Reproduction

- 1. Agaricus reproduce by sexual method but sex organs are absent.
- 2. Most of the species are heterothallic but Agaricus bisporus only homothallic species
- 3. Opposite strains of primary mycelium fused by the somatogamy and produce dikaryotic mycelium
- 4. Karyogamy takes place in basidium and undergo meiosis cell division and produce four haploid basidiospores
- 5. Basidiospores are attached with basidium through a small stalk is called Sterigmata.

Structure of Basidiocarp

The mature basidiocarp is umbrella shaped and it is divided into four parts. Namely Stipe, Annulus, Gill and Pileus

- Stipe – Stipe is stalk like thick, flesh, hollow, cylindrical structure. It is made up of Pseudoparenchymatous structure.
- Annulus – The upper part of the stipe with a membranous structure is called annulus.
- Pileus – The upper convex surface of agaricus is called pileus.
- Gill or Lamellae – The inner surface of the pileus is called gill or lamellae

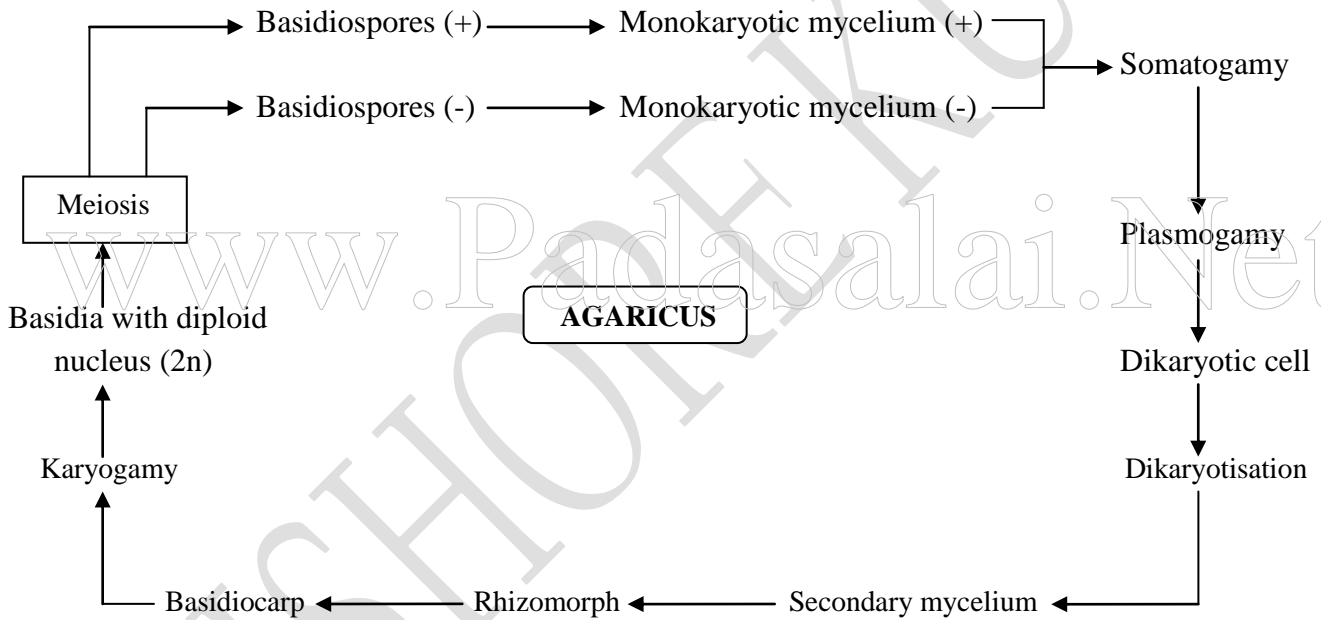
Structure of Gill or Lamellae

The gill or lamellae is divided into following parts such as...

- ❖ Trama – The central part of the gill between two sub hymenium layer is called trama.
- ❖ Sub hymenium – It is present in between trama and hymenium, it's have closely, compactly arranged tissues
- ❖ Hymenium – On both side of the gill a fertile layer called hymenium
- ❖ Basidium – Hymenium posses club shaped structure is called basidium which is produce basidiospores
- ❖ Paraphysis – The sterile part of the hymenium is called paraphysis
- ❖ Basidiospores – Each basidium produce four basidiospores. Among this two are (+) strains and two are (-) strains
- ❖ Sterigmata – Basidiospores are attached with basidium through a small stalk like structure is called sterigmata.

Life cycle of Agaricus

The life cycle of Agaricus shows very short haploid, diploid phase and a prolonged dikaryotic phase



Chapter-I Living world - Fungi**Total: 50****I.Choose the Correct Answer****10x1 = 10**

1. Dolipore septum is characteristic feature of
a) Oomycetes b) Basidiomycetes c) Ascomycetes d) Zygomycetes
2. Fungi growing in Dung are called
a) Nematogenous fungi b) Osmophilic fungi c) Dermatophytic fungi d) Coprophilous fungi
3. The rust disease of wheat is caused by
a) Puccinia b) Ustilago c) Albugo d) Colletotrichum
4. The group of fungi producing zoospores is
a) Basidiomycetes b) Ascomycetes c) Mastigomycotina d) Zygomycotina
5. The symbiotic association between the roots of higher plants and fungal mycelium is called
a) Commensalism b) Heterothallism c) Lichens d) Mycorrhizae
6. The sexual stage of fungi is called
a) Teleomorph b) Anamorph c) Eucarpic d) Holocarpic
7. Which one of the fungus has sporangium
a) *Mucor* b) *Colletotrichum* c) *Fusarium* d) *Puccinia*
8. Father of Indian Mycology is
a) B.B. Mundkur b) P.A. Micheli c) K.C. Mehta d) E.J. Butler
9. A Completely closed ascocarp is called
a) Apothecium, b) Pseudothecium c) Perithecium d) Cleistothecium
10. Identify the odd man out
a) *Peziza* b) *Morchella* c) *Polyporus* d) *Neurospora*

II. Answer any five questions**5 x 2 = 10**

11. Define heterothallism.
12. What is Basidia.
13. What are toad stools.
14. What is apothecium. Give example.
15. Define the term Plectenchyma.
16. Mention two edible fungi.
17. Name the cell wall material of Fungi.

III. Answer any five questions**5 x 3 = 15**

18. Explain the structure of basidiocarp of *Agaricus*.
19. List down the salient features of Ascomycetes.
20. Discuss on the asexual reproduction in fungi.
21. List out the plant diseases caused by fungi.
22. Draw the structure of *Agaricus* and label the parts.
23. Write the human diseases caused by fungi.
24. Draw the structure of *Rhizopus* and label the parts.

IV. Answer any three of the following question**3 x 5 = 15**

25. Outline the classification of fungi proposed by Alexopoulos and Mims.
26. Give an account on Economic importance of fungi.
27. Write the general characteristic features of fungi.
28. Explain the sexual reproduction methods in fungi.
29. List down the salient features of Basidiomycetes.
30. Outline chart of Life cycle of *Rhizopus*.
