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QUESTION BANK

Based On NEP 2020

B.Sc. II SEM

ARCHEGONIATES AND PLANT ARCHITECTURE

- Brief and Intensive Notes
- Multiple Choice Questions

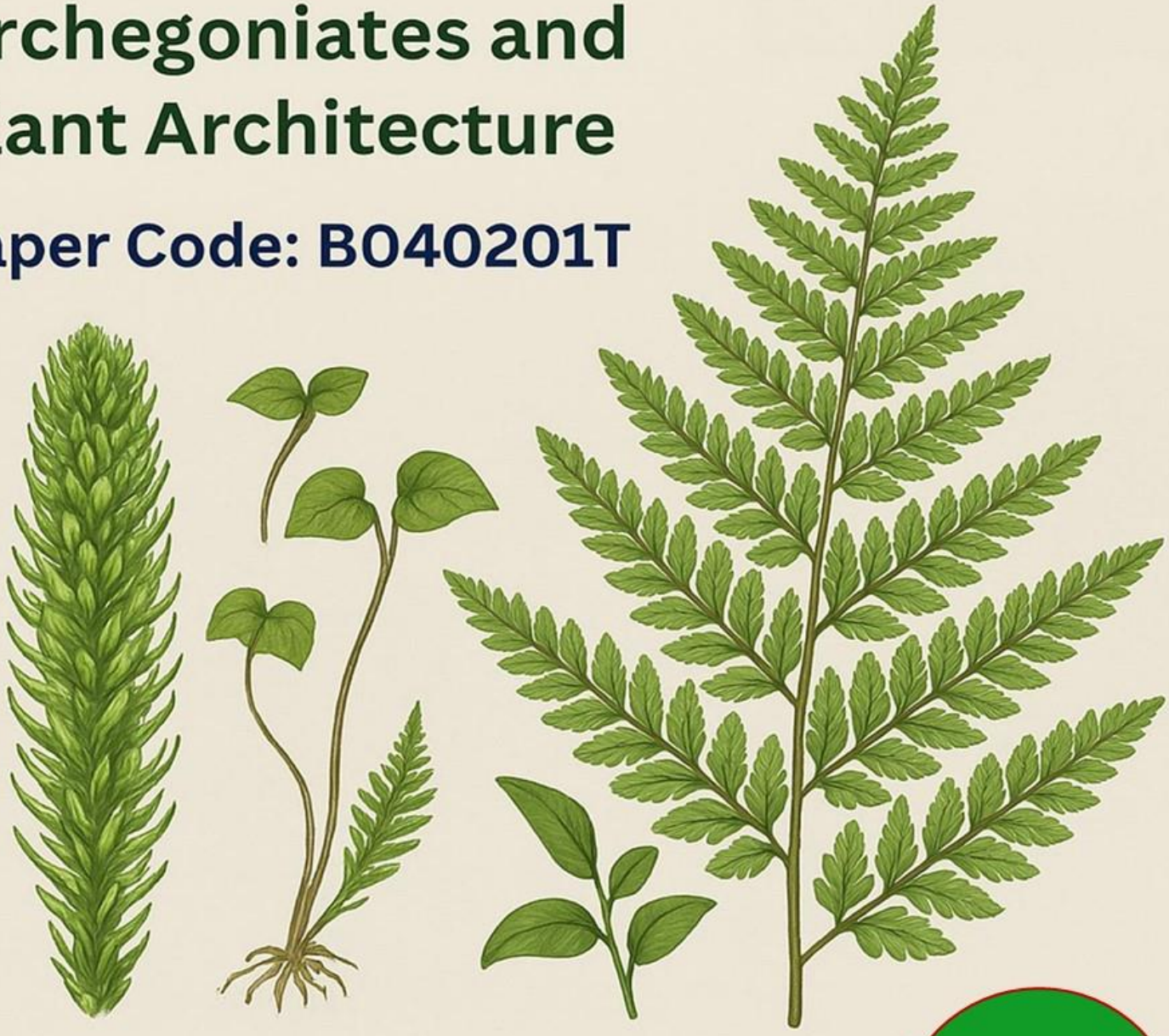
DR. SAMIKSHA SINGH

B.Sc. Semester II

Subject: Botany

Paper Title: Archegoniates and Plant Architecture

Paper Code: B040201T



600+ MCQs

Question Bank Prepared by

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Syllabus

Subject: **Botany**
Course Code: **B040201T**
Course Title: **Archegoniates and Plant Architecture**

Unit	Topic	Lectures (60 h)
I	**Introduction to Archegoniates & Bryophytes** Unique features of archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Riccia*, *Marchantia, Anthoceros and Funaria*. (Developmental details not to be included). economic importance of bryophytes.	7
II	**Pteridophytes** General characteristics, Early land plants (*Rhynia*). Classification (up to family) with Examples. General account of *Lycopodium*, *Selaginella, Equisetum*, and *Azolla* (Developmental details not to be included). Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes.	8
III	**Gymnosperms** Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction. General account of *Cycas*, *Pinus*, and *Ephedra*. (Developmental details not to be included). economic importance of Gymnosperms	8
IV	**Palaeobotany** General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Brief account of process of fossilization & types of fossils and study techniques; Contribution of Birbal Sahni	8
V	**Angiosperm Morphology (Stem, Roots, Leaves & Flowers, Inflorescence)** Morphology and modifications of roots; Stem, leaf and bud. Types of inflorescences; flowers, flower parts, fruits and types of placentation; Definition and types of seeds.	7
VI	**Plant Anatomy:** Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica - Corpus theory. Secondary growth - Root and stem-cambium (structure and function) annular rings, Anomalous secondary growth - *Bignonia, Boerhaavia, Dracaena,Nyctanthes*	7
VII	**Reproductive Botany** Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Methods of pollination, Germination of pollen grain, structure of male gametophyte, Fertilization, structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and polyembryony.	8
VIII	**Palynology:** Pollen structure, pollen morphology, pollen allergy, Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidences.	7

UNIT-I: Introduction of Archegoniates & Bryophytes

Introduction to Archegoniates: -

Archegoniates are a group of land plants (Embryophytes) that produce a female reproductive organ called archegonium. This archegonium is a multicellular, flask-shaped structure with a long neck and a swollen basal region (venter) that encloses the egg cell.

Archegoniates include:

- ✓ Bryophytes (mosses, liverworts, and hornworts)
- ✓ Pteridophytes (ferns and their allies)
- ✓ Gymnosperms (conifers and other non-flowering seed plants)

These plants are distinguished from thallophytes (like algae and fungi) and angiosperms (flowering plants, which have more advanced reproductive structures).

Key Features of Archegoniates:

- ✓ Adaptations to terrestrial life, such as the presence of a cuticle, stomata, and vascular tissues (in pteridophytes and gymnosperms).
- ✓ Alternation of generations with a dominant sporophyte in pteridophytes and gymnosperms, and dominant gametophyte in bryophytes.
- ✓ Multicellular archegonium with a protective layer.
- ✓ Retention of zygote and embryo within the female gametophyte (matrotrophy).

Archegonium – Structure and Function: -

The archegonium is a highly specialized structure for sexual reproduction. It is made up of:

- ✓ **Neck cells:** Form a canal through which the male gametes (sperm) swim.
- ✓ **Venter:** Swollen base containing the egg cell and a venter canal cell.
- ✓ **Neck canal cells:** Disintegrate at maturity to form a passage for the sperm.
- ✓ During fertilization, antherozoids (male gametes) swim through the neck canal in a film of water and fuse with the egg cell to form a zygote, which then develops into the embryo.
- ✓ The archegonium protects the egg, facilitates fertilization, and supports the early development of the embryo.

Classification and Comparison of Archegoniates: -

1. Bryophytes

- ✓ Dominant gametophyte generation.
- ✓ Archegonia develop on the gametophyte.

- ✓ The sporophyte is dependent on the gametophyte.
- ✓ Require water for fertilization (flagellated sperm).
- ✓ Example: Riccia, Marchantia, Anthoceros, Funaria.

2. Pteridophytes

- ✓ Dominant sporophyte generation.
- ✓ Gametophyte is independent but small and short-lived.
- ✓ Archegonia form on the prothallus (gametophyte).
- ✓ Require water for fertilization.
- ✓ Example: Lycopodium, Selaginella, Fern.

3. Gymnosperms

- ✓ Dominant sporophyte generation.
- ✓ Female gametophyte develops within the ovule.
- ✓ Archegonia are embedded in the female gametophyte.
- ✓ Fertilization does not require external water.
- ✓ Example: Cycas, Pinus.

Evolutionary Significance of Archegoniates:-

- ✓ The emergence of archegonia marked a major evolutionary step in the colonization of land by plants. The structure of archegonia:
  - ➢ Protect the gametes and developing embryo from desiccation.
  - ➢ Allowed fertilization and development in a controlled internal environment.
  - ➢ Led to the evolution of embryo retention and eventually to seed development.
  - ➢ Archegoniates bridge the evolutionary gap between simple, aquatic plants and the highly advanced, seed-bearing plants.

Importance of Archegoniates in Plant Evolution: -

- ✓ Bryophytes represent the first land plants with archegonia.
- ✓ Pteridophytes introduced vascular tissues for support and transport.
- ✓ Gymnosperms advanced further with seed habit and internal fertilization.
- ✓ These groups laid the foundation for angiosperm evolution by developing complex reproductive strategies, adaptation to dry environments, and specialized tissues.

General Characteristics of Bryophytes: -

Bryophytes are non-vascular cryptogams, meaning they lack xylem and phloem.

- ✓ Represent the first land plants in plant evolution.
- ✓ Dominant gametophyte: The main, independent, photosynthetic phase of the plant is haploid (n).

- ✓ Sporophyte is diploid (2n), dependent on the gametophyte for nutrition and support.
- ✓ Grow in moist, shady habitats, but show adaptations for terrestrial life.
- ✓ Do not possess true roots, stems, or leaves but have structures that resemble them.
- ✓ Rhizoids (unicellular or multicellular) anchor the plant and help in water absorption.
- ✓ Reproduction is both vegetative and sexual; spores are produced in sporophyte.
- ✓ Water is essential for fertilization, as motile sperm swim to the egg.
- ✓ Exhibit alternation of generations – haploid gametophyte alternates with diploid sporophyte.

Adaptations to Land Habit: -

Despite lacking vascular tissues, bryophytes exhibit several adaptations to survive on land:

Adaptation **Function**

- Cuticle or waxy covering: - Reduces water loss from the surface.
- Multicellular sex organs: Protect gametes from desiccation and mechanical damage.
- Protected zygote and embryo: - Embryo develops inside the archegonium ensuring nourishment.
- Rhizoids: - Anchor the plant body and absorb water.
- Spores (tetraspore) with sporopollenin: - Highly resistant to desiccation and UV radiation.
- Cushion-like growth forms: - Retain moisture and reduce exposure to dry air.

Classification (Up to Family Level): -

Division Bryophyta is traditionally divided into three classes as per G. M. Smith (1938):

Class	Order	Family	Example(s)
Hepaticopsida (Liverworts)	Marchantiales	Ricciaceae, Marchantiaceae	Riccia, Marchantia
Anthocerotopsida (Hornworts)	Anthocerotales	Anthocerotaceae	Anthoceros
Bryopsida (Mosses)	Funariales	Funariaceae	Funaria

Range of Thallus Organization: -

- ➢ Bryophytes show a wide range of gametophyte forms, from simple thallus to complex leafy structures:
- ➢ Thalloid forms (e.g., Riccia, Marchantia): Flat, dorsiventral body without true roots, stems, or leaves.

- Leafy forms (e.g., Funaria, Polytrichum): Small axis bearing spirally arranged leaf-like structures.
- Simplicity to complexity: Riccia (simple thallus) → Marchantia (thallus with air chambers, pores) → Anthoceros (thallus with embedded sex organs and chloroplasts) → Funaria (leafy, upright structure).

Morphology, Anatomy, and Reproduction: -

A. Riccia (Liverwort)

Morphology: Dorsiventrally flattened thallus, rosette-shaped, dichotomous branching, grows prostrate.

Anatomy:

- No air chambers or pores.
- Dorsal chlorophyllous region and ventral storage region.
- Rhizoids (unicellular) and scales on the ventral side.

Reproduction:

- Vegetative: Fragmentation, adventitious branches.
- Sexual: Monoecious; antheridia and archegonia sunken in dorsal grooves.
- Sporophyte: Simplest; consists of a capsule only (no foot or seta), remains embedded in the gametophyte.

B. Marchantia (Liverwort)

Morphology: Broad thallus with midrib and lobed margin; has dorsal gemma cups and ventral rhizoids and scales.

Anatomy:

- Dorsal surface has air pores leading to air chambers with photosynthetic filaments.
- Storage tissues below contain starch and oil bodies.

Reproduction:

- Vegetative: Gemmae—asexual propagules formed in gemma cups.
- Sexual: Dioecious; sex organs borne on stalked structures:
- Antheridiophore (male): disc-shaped head with embedded antheridia.
- Archegoniophore (female): umbrella-like head with archegonia hanging down.
- Sporophyte: Differentiated into foot, seta, and capsule; elaters assist in spore dispersal.

C. Anthoceros (Hornwort)

Morphology: Flattened rosette-like thallus, dark green, dorsiventral; grows on moist soil.

Anatomy:

- Each cell contains a large chloroplast with pyrenoid.
- Mucilage cavities and embedded sex organs.
- Possesses symbiotic cyanobacteria (Nostoc) in mucilage chambers.

Reproduction:

Vegetative: Fragmentation.

- Sexual: Mostly monoecious; antheridia and archegonia sunken in the thallus.
- Sporophyte: Long, horn-like; has foot and capsule (no seta).
- Grows continuously due to a basal meristem.
- Capsule is photosynthetic, has stomata, and releases spores gradually.

D. Funaria (Moss)

Morphology: Leafy plant body with central axis and spirally arranged leaves; multicellular rhizoids with oblique septa.

Anatomy:

- Central conducting strand (hydroids and leptoids).

Reproduction:

- Vegetative: Formation of protonema—a filamentous juvenile stage.
- Sexual: Monoecious; male and female sex organs at the apex of leafy shoots.
- Surrounded by perichaetial and perigonial leaves.
- Sporophyte: Complex structure with:
- Foot, Seta, and Capsule.
- Capsule has operculum and peristome teeth for regulated spore release.

Economic Importance of Bryophytes: -

- ✓ **Soil conservation: -** Moss mats prevent erosion in hilly areas.
- ✓ **Water retention: -** Sphagnum moss can hold water 20–30 times its dry weight; used in horticulture.
- ✓ **Peat formation: -** Sphagnum forms peat used as fuel, packing material, and soil conditioner.
- ✓ **Medicinal uses: -** Antimicrobial and wound-healing properties in some liverworts and mosses.
- ✓ **Bioindicators: -** Sensitive to pollutants; used to monitor air and water quality.
- ✓ **Ecological succession: -** Bryophytes are pioneer species on rocks and bare soil, contributing to soil formation.

1. Which of the following is a unique feature of archegoniates?
   a) Siphonogamy
   b) Oogamous reproduction
   c) Absence of archegonia
   d) Presence of pollen tube

   Answer: b) Oogamous reproduction

2. In archegoniates, the archegonium is generally:
   a) A single-celled structure
   b) A multicellular, flask-shaped structure
   c) A unicellular gametangium
   d) Antheridium-like in function

   Answer: b) A multicellular, flask-shaped structure

3. The egg in an archegonium is located in which part?
   a) Neck canal
   b) Venter
   c) Antheridium
   d) Thallus

   Answer: b) Venter

4. The male gametangium in archegoniates is known as:
   a) Archegonium
   b) Venter
   c) Antheridium
   d) Capsule

   Answer: c) Antheridium

5. Which among the following groups does NOT belong to archegoniates?
   a) Bryophytes
   b) Pteridophytes
   c) Gymnosperms
   d) Angiosperms

   Answer: d) Angiosperms

6. Bryophytes are known as amphibians of the plant kingdom because:
   a) They grow only in water
   b) They need water for fertilization
   c) They reproduce by seeds

d) They lack chlorophyll

Answer: b) They need water for fertilization

7. Which of the following is NOT a characteristic of bryophytes?

a) Lack of true vascular tissues
b) Dominant sporophytic generation
c) Dependence on water for reproduction
d) Gametophyte as the dominant phase

Answer: b) Dominant sporophytic generation

8. The dominant phase in the life cycle of bryophytes is:

a) Sporophyte
b) Gametophyte
c) Both equally dominant
d) None of the above

Answer: b) Gametophyte

9. Which part of bryophytes performs photosynthesis?

a) Sporophyte
b) Gametophyte
c) Rhizoids
d) Antheridia

Answer: b) Gametophyte

10. Calyptra develops from:

a) Venter of the archegonium
b) Neck of the archegonium
c) Outgrowth of the gametophyte
d) Outgrowth of the sporophyte

Answer: a) Venter of the archegonium

11. An archegonium of Riccia has:

a) 4 NCC, 1 VCC and an oospore
b) 4 NCC, 2 VCC and an oospore
c) 4 NCC, 3 VCC and two oospores
d) 4 NCC, 1 VCC and two oospores

Answer: a) 4 NCC, 1 VCC and an oospore

12. Elaters in bryophytes are:

a) Haploid

b) Diploid
c) Triploid
d) None of the above

Answer: b) Diploid

13. In which one of the following, archegonia appear inverted on a mature gametophyte:
a) Riccia
b) Marchantia
c) Anthoceros
d) Pellia

Answer: b) Marchantia

14. Septate rhizoids are found in:
a) Hepaticopsida
b) Anthocerotopsida
c) Bryopsida
d) None of the above

Answer: c) Bryopsida

15. Annulus in in moss capsule separates
a) Operculum from columella
b) Theca from columella
c) Operculum from theca
d) Columella from apophysis

Answer: c) Operculum from theca

16. Number of peristome teeth in Funaria capsule is:
a) 16 in one whorl
b) 16 in two whorls
c) 32 in two whorls
d) 32 in one whorl

Answer: c) 32 in two whorls

17. Funaria attaches to substratum through rhizoids which are?
a) Green, branched, thread-like structures
b) Unbranched structures
c) Branched with obligate septa
d) Branched with plane septa

Answer: c) Branched with obligate septa

18. In moss gametophyte, a branch always originates from:
a) Axis of the leaf
b) Below the leaf
c) Above the leaf
d) Besides the leaf

Answer: a) Axis of the leaf

19. Club-shaped antheridia are found in:
a) Riccia
b) Funaria
c) Pteris
d) Lycopodium

Answer: b) Funaria

20. The number of neck canal cells in Marchantia is:
a) 4
b) 6
c) 8
d) 10

Answer: c) 8

21. Name a bryophyte which harbours *Nostoc* colonies in its thallus:
a) Riccia
b) Marchantia
c) Sphagnum
d) Anthoceros

Answer: d) Anthoceros

22. Hornwort is a common name of:
a) Riccia
b) Pellia
c) Porella
d) Anthoceros

Answer: d) Anthoceros

23. In which bryophyte, the sporophyte is partially independent with unlimited growth:
a) Anthoceros

b) Sphagnum
c) Porella
d) Marchantia

Answer: a) Anthoceros

24. The air cavities in the capsule of moss are partitioned with delicate strands of cells, which are called?

a) Trabeculae
b) Compartments
c) Partitions
d) Septa

Answer: a) Trabeculae

25. Sporangium of Riccia is differentiated into:

a) Seta, Capsule
b) Foot, Seta, Capsule
c) A simple capsule
d) Portend seta only

Answer: c) A simple capsule

26. Sex organs in bryophytes are:

a) Unicellular and jacketed
b) Unicellular and non-jacketed
c) Multicellular and jacketed
d) Multicellular and non-jacketed

Answer: c) Multicellular and jacketed

27. Bryophytes are:

a) Heterosporous
b) Homosporous
c) Homosporous or Heterosporous
d) None of the above

Answer: b) Homosporous

28. The term 'Bryophyte' was first given by:

a) Linnaeus
b) Braun
c) O. Tippo
d) Schimper

Answer: b) Braun

29. The presence of pyrenoid is shown by which bryophyte?
a) Riccia
b) Marchantia
c) Anthoceros
d) All of these

Answer: c) Anthoceros

30. The rhizoids of Riccia are:
a) Multicelled, smooth walled, and tuberculated
b) Multicelled, and tuberculated
c) Unicelled, smooth walled, and tuberculated
d) Unicelled and smooth walled

Answer: c) Unicelled, smooth walled, and tuberculated

31. Bryophytes can be differentiated from thallophyta on which of the following character
a) In bryophytes, sporophyte is completely dependent on the gametophyte
b) Bryophytes are generally terrestrial
c) Rhizoids are more common in bryophytes
d) All of the above

Answer: a) In bryophytes, sporophyte is completely dependent on the gametophyte

32. Bryophytes grown in moist and shady environments because:
a) They grow on land
b) Their gametes fuse in water
c) They lack vascular tissue
d) They lack roots and stomata

Answer: b) Their gametes fuse in water

33. The first land inhabiting plants are:
a) Bryophytes
b) Angiosperms
c) Gymnosperms
d) Pteridophyta

Answer: a) Bryophytes

34. The largest archegonium of plant kingdom is present in:

a) Riccia
b) Marchantia
c) Funaria
d) Anthoceros

Answer: c) Funaria

35. The most primitive land plants evolved are:
a) Algae
b) Bryophytes
c) Fungi
d) Pteridophyta

Answer: b) Bryophytes

36. A protective covering called 'calyptra' is formed by:
a) Wall of neck
b) Wall of venter
c) Stalk
d) Formed as a new structure

Answer: b) Wall of venter

37. In Marchantia, antherozoids are:
a) Rod-shaped and bicilliate
b) Short and bicilliate
c) Short, curved, multicilliate
d) Long, curved, multicilliate

Answer: a) Rod-shaped and bicilliate

38. What is the characteristic branching pattern of Riccia thallus?
a) Monopodial
b) Excurrent
c) Dichotomous
d) Bipodial

Answer: c) Dichotomous

39. Which one of the following is NOT a characteristic feature of bryophytes?
a) Dominant gametophyte generation
b) Filamentous rhizoids
c) Amphibious habit

d) Vascular tissue

Answer: d) Vascular tissue

40. In which bryophyte, the sporophyte is embedded in thallus?
a) Riccia
b) Marchantia
c) Funaria
d) Anthoceros

Answer: a) Riccia

41. In moss, reduction division' takes place in:
a) Capsule
b) Seta
c) Archegonia
d) Antheridium

Answer: a) Capsule

42. Gemmae are:
a) Specialized unicellular sexual reproductive bodies
b) Specialized unicellular asexual reproductive bodies
c) Specialized multicellular sexual reproductive bodies
d) Specialized multicellular asexual reproductive bodies

Answer: d) Specialized multicellular asexual reproductive bodies

43. Elongated cylindrical sporogenous tissue is a characteristic of:
a) Anthoceros
b) Marchantia
c) Funaria
d) Riccia

Answer: a) Anthoceros

44. In Anthoceros, the sporogenous tissue is derived from:
a) Gametophytic phase
b) Endothecium tissue
c) Amphithecium tissue
d) None of these

Answer: c) Amphithecium tissue

45. In which of the following, paraphyses and antheridia occur together:
a) Anthoceros
b) Riccia
c) Funaria
d) Marchantia

Answer: c) Funaria

46. The basal swollen portion of the archegonium is:
a) Oospore
b) Venter
c) Jacket
d) Neck

Answer: b) Venter

47. Peristomial teeth help in:
a) Protection of spores
b) Dehiscence of capsule
c) Dispersal of seeds
d) Discharge of spores

Answer: d) Discharge of spores

48. In Anthoceros, the central axis of tissue known as columella is formed from:
a) Endothecium
b) Amphithecium
c) Endothecium and Amphithecium
d) None of these

Answer: a) Endothecium

49. Rhizoids in Funaria arise from:
a) Basal region
b) Ventral region
c) Dorsal region
d) Lateral region

Answer: b) Ventral region

50. Bryophytes are probably evolved from:
a) Blue green algae
b) Green algae
c) Red algae
d) Brown algae

Answer: b) Green algae

51. Scales in Riccia are:
a) Multicelled and appendiculate
b) Multicelled and ligulate
c) Unicelled and ligulate
d) Unicelled and appendiculate

Answer: a) Multicelled and appendiculate

52. Pseudo-elaters are characteristic of the sporophyte of:
a) Funaria
b) Anthoceros
c) Marchantia
d) Riccia

Answer: b) Anthoceros

53. Pseudo-elaters in Anthoceros capsule are formed from:
a) Endothecium
b) Columella
c) Outer amphithecium
d) Inner amphithecium

Answer: d) Inner amphithecium

54. In Mosses, sex organs are seen in:
a) Protonema stage
b) Seta of sporophyte
c) Leafy stage
d) Capsule of sporophyte

Answer: c) Leafy stage

55. Elaters are not found in the capsule of
a) Riccia
b) Anthoceros
c) Marchantia
d) Pellia

Answer: a) Riccia

56. Fossil bryophytes have been recorded from the:
a) Secondary beds of Coenozoic era
b) Tertiary beds of Palaeozoic era
c) Secondary beds of Palaeozoic era
d) Tertiary beds of Coenozoic era

Answer: d) Tertiary beds of Coenozoic era

57. Greek word 'Bryon' means:
a) Moss
b) None of these
c) Ferns
d) Bryophyta

Answer: a) Moss

58. Which among the following shows the maximum fertility of sporogenous tissue?
a) Funaria
b) Riccia
c) Marchantia
d) Plagiochasma

Answer: b) Riccia

59. The book 'Liverworts of Western Himalaya' was written by:
a) Shiv Ram Kashyap
b) Campbell
c) Smith
d) Ramudar

Answer: a) Shiv Ram Kashyap

60. Sterile jacket around gametangia is a feature of:

a) Algae
b) Bryophytes
c) Lichens
d) Fungi

Answer: b) Bryophytes

61. Who among the following is regarded as the father of Indian Bryology:
a) Birbal Sahni
b) S.R. Kashyap
c) P. Maheshwari
d) P.N. Mehra

Answer: b) S.R. Kashyap

62. The bryophyte sporophyte is:
a) Independent
b) Photosynthetic in all species
c) Dependent on the gametophyte
d) Always diploid

Answer: c) Dependent on the gametophyte

63. Bryophytes are classified into:
a) Liverworts, mosses, hornworts
b) Ferns, mosses, algae
c) Pteridophytes, mosses, lichens
d) Algae, fungi, liverworts

Answer: a) Liverworts, mosses, hornworts

64. The members of Hepaticopsida (Liverworts) reproduce vegetatively by:
a) Gemmae
b) Spores
c) Conjugation
d) Budding

Answer: a) Gemmae

65. Hornworts (Anthocerotopsida) are characterized by:
a) Presence of oil bodies
b) Sporophyte with a meristematic zone
c) Non-green sporophyte

d) Presence of rhizoids with septa

Answer: b) Sporophyte with a meristematic zone

66. The protonema stage is a characteristic of:
a) Liverworts
b) Hornworts
c) Mosses
d) Algae

Answer: c) Mosses

67. The conducting cells in mosses are called:
a) Xylem and phloem
b) Hydroids and leptoids
c) Sclerenchyma
d) Collenchyma

Answer: b) Hydroids and leptoids

68. Riccia is classified under:
a) Anthocerotopsida
b) Bryopsida
c) Hepaticopsida
d) Pteridophytes

Answer: c) Hepaticopsida

69. Marchantia reproduces asexually by:
a) Gemma cups
b) Conidia
c) Conjugation
d) Binary fission

Answer: a) Gemma cups

70. The sporophyte of Riccia lacks:
a) Capsule
b) Foot and seta
c) Elaters

d) All of the above

Answer: d) All of the above

71. Anthoceros has a sporophyte that:
a) Has an intercalary meristem
b) Is completely dependent on gametophyte
c) Is non-photosynthetic
d) Does not produce spores

Answer: a) Has an intercalary meristem

72. Funaria belongs to which class?
a) Hepaticopsida
b) Anthocerotopsida
c) Bryopsida
d) Pteropsida

Answer: c) Bryopsida

73. Peat is obtained from:
a) Riccia
b) Sphagnum
c) Funaria
d) Marchantia

Answer: b) Sphagnum

74. Bryophytes help in soil conservation by:
a) Preventing soil erosion
b) Enhancing water retention
c) Acting as bioindicators
d) All of the above

Answer: d) All of the above

75. Which bryophyte is used as packing material?
a) Marchantia
b) Anthoceros

c) Sphagnum
d) Riccia

Answer: c) Sphagnum

76. Which of the following bryophytes has medicinal properties?
a) Marchantia
b) Funaria
c) Riccia
d) Sphagnum

Answer: d) Sphagnum

77. Bryophytes are used as indicators of:
a) Pollution
b) Soil fertility
c) Crop production
d) Climate change

Answer: a) Pollution

78. The distinguishing feature of archegoniates is:
a) Motile male gametes
b) Fertilization occurring within the archegonium
c) Gametophytic dominance
d) Presence of flowers

Answer: b) Fertilization occurring within the archegonium

79. The zygote in archegoniates develops into:
a) Gametophyte
b) Sporophyte
c) Prothallus
d) Protonema

Answer: b) Sporophyte

80. Which of the following groups of plants are considered closest to the ancestral land plants?
a) Pteridophytes
b) Gymnosperms

c) Bryophytes
d) Angiosperms

Answer: c) Bryophytes

81. In archegoniates, the sporophyte generation:
a) Is always independent
b) Produces spores
c) Produces gametes
d) Is haploid

Answer: b) Produces spores

82. The presence of multicellular gametangia is a defining characteristic of:
a) Bryophytes
b) Pteridophytes
c) Gymnosperms
d) All archegoniates

Answer: d) All archegoniates

83. The first stage of development in mosses is called:
a) Protonema
b) Sporophyte
c) Gemma
d) Zygote

Answer: a) Protonema

84. Which of the following bryophytes have a thalloid body structure?
a) Marchantia
b) Funaria
c) Polytrichum
d) Sphagnum

Answer: a) Marchantia

85. Bryophytes lack:
a) Flowers and seeds
b) Gametophyte generation

c) Alternation of generations
d) Haploid spores

Answer: a) Flowers and seeds

86. Bryophytes reproduce asexually by:
a) Fragmentation
b) Budding
c) Spore formation
d) All of the above

Answer: d) All of the above

87. In bryophytes, rhizoids function as:
a) Water-absorbing structures
b) Photosynthetic organs
c) Reproductive structures
d) Supportive tissue

Answer: a) Water-absorbing structures

88. The main criterion for classifying bryophytes into Hepaticopsida, Anthocerotopsida, and Bryopsida is:
a) Structure of gametophyte and sporophyte
b) Presence of vascular tissue
c) Mode of nutrition
d) Habitat preference

Answer: a) Structure of gametophyte and sporophyte

89. Which of the following is a characteristic feature of liverworts?
a) Leafy gametophyte
b) Sporophyte with stomata
c) Presence of gemma cups
d) Vascular tissue

Answer: c) Presence of gemma cups

90. The sporophyte of hornworts is unique because it:
a) Has a continuous meristematic zone

b) Lacks a capsule
c) Is completely independent of the gametophyte
d) Contains true xylem

Answer: a) Has a continuous meristematic zone

91. The leafy gametophyte is a characteristic of:
a) Liverworts
b) Hornworts
c) Mosses
d) Charophytes

Answer: c) Mosses

92. Which class of bryophytes has the most advanced sporophyte?
a) Hepaticopsida
b) Anthocerotopsida
c) Bryopsida
d) Charophyta

Answer: c) Bryopsida

93. The sporophyte of Riccia is:
a) Highly developed
b) A simple structure lacking foot and seta
c) Independent of the gametophyte
d) Photosynthetic

Answer: b) A simple structure lacking foot and seta

94. Gemmae in Marchantia are produced in:
a) Gemma cups
b) Rhizoids
c) Archegonia
d) Protonema

Answer: a) Gemma cups

95. Which of the following bryophytes shows the most primitive sporophyte?
a) Riccia

b) Marchantia
c) Anthoceros
d) Funaria

Answer: a) Riccia

96. Anthoceros differs from Riccia and Marchantia because it has:
a) A more advanced sporophyte with stomata
b) Rhizoids with septa
c) A completely independent sporophyte
d) No gametophyte

Answer: a) A more advanced sporophyte with stomata

97. The seta in the sporophyte of Funaria helps in:
a) Absorption of nutrients
b) Providing mechanical support
c) Elevating the capsule for spore dispersal
d) Photosynthesis

Answer: c) Elevating the capsule for spore dispersal

98. Which bryophyte is used in seedbeds for water retention?
a) Marchantia
b) Riccia
c) Sphagnum
d) Anthoceros

Answer: c) Sphagnum

99. The ability of Sphagnum to hold water is due to:
a) Dead hyaline cells in leaves
b) Presence of xylem
c) Thick cell walls
d) Presence of tracheids

Answer: a) Dead hyaline cells in leaves

100. Bryophytes act as pioneer species in:
a) Secondary succession

b) Primary succession
c) Marine ecosystems
d) Deep forests

Answer: b) Primary succession

101. Mosses are used as bioindicators because they:
a) Absorb heavy metals from the environment
b) Grow only in clean water
c) Need high levels of oxygen
d) Produce secondary metabolites

Answer: a) Absorb heavy metals from the environment

102. Peat moss is commercially important because it:
a) Is used in making biofuels
b) Has high water retention capacity
c) Serves as a soil conditioner
d) All of the above

Answer: d) All of the above

UNIT-II: Pteridophytes

General Characteristics of Pteridophytes: -

- ✓ Pteridophytes are the first group of vascular cryptogams in the plant kingdom.
- ✓ They occupy a position between Bryophytes and Gymnosperms in plant evolution.
- ✓ Dominant plant body is a diploid sporophyte, which is independent and differentiated into roots, stems, and leaves.
- ✓ Vascular tissue system is present (xylem and phloem) for conduction of water, minerals, and food.
- ✓ Leaves are either microphyllous (small, single-veined) or macrophyllous (larger with complex venation).
- ✓ Spores are produced in sporangia, which may be borne singly or in groups called sori (as in ferns).
- ✓ Reproduction is asexual (via spores) and sexual (via gametes).
- ✓ Gametophyte (prothallus) is haploid, photosynthetic or saprophytic, and independent or partially dependent.
- ✓ Life cycle exhibits heteromorphic alternation of generations.
- ✓ Found in diverse habitats—terrestrial, aquatic, epiphytic, and even xerophytic environments.

Early Land Plants – Rhynia: -

- ✓ Rhynia is a genus of extinct early vascular land plants from the Devonian period (approx. 400 million years ago).
- ✓ Discovered by Robert Kidston and William Henry Lang in 1917, from the Rhynie chert in Aberdeenshire, Scotland.
- ✓ Plant body was simple, leafless, rootless, with dichotomous branching.
- ✓ Possessed rhizoids for anchorage instead of roots.
- ✓ The stem had a protostele (central solid strand of xylem surrounded by phloem).
- ✓ Sporangia were terminal and homosporous.
- ✓ Considered a link between bryophytes and vascular plants, as it had vascular tissues but simple morphology.
- ✓ Represents a primitive evolutionary stage of land plant colonization.

Classification of Pteridophytes (Up to Family Level) by G.M. Smith (1955): -

Division – Tracheophyta

(Plants with vascular tissues: xylem and phloem)

Sub-division – Pteridophyta
(Vascular cryptogams; spore-producing plants without seeds)

Class I – Psilopsida
(Simplest vascular plants, no true roots, dichotomous branching)

Order – Psilotales
Family – Psilotaceae

Class II – Lycopsida
(Club mosses; microphyllous leaves, protostelic stems)

Order – Lycopodiales
Family – Lycopodiaceae-Example-Lycopodium

Order – Selaginellales
Family – Selaginellaceae, Example-Selaginella

Order – Isoetales
Family – Isoetaceae

Class III – Sphenopsida (Equisetopsida)
(Horsetails; jointed stems, whorled microphyllous leaves)

Order – Equisetales
Family – Equisetaceae, Example- Equisetum

Class IV – Pteropsida (Filicopsida)
(True ferns; megaphyllous leaves, mostly leptosporangiate)

1. Sub-class – Eusporangiatae
(Spore-producing structures develop from multiple initial cells)

Order – Ophioglossales
Family – Ophioglossaceae

Order – Marattiales
Family – Marattiaceae

2. Sub-class – Leptosporangiatae

(Spore-producing structures develop from a single initial cell)

Order – Filicales

Families –

- Polypodiaceae
- Dennstaedtiaceae
- Dryopteridaceae
- Pteridaceae
- Thelypteridaceae
- Aspleniaceae

3. Sub-class – Hydropterides (Aquatic ferns)

(Include heterosporous, water-loving ferns)

Order – Salviniales

Families –

- Salviniaceae, Example- Azolla
- Marsileaceae, Example- Marsilea

General Account of Some Pteridophytes-

A. Lycopodium (Club Moss)

- ✓ Herbaceous or trailing plants.
- ✓ Stem dichotomously branched or monopodial.
- ✓ Microphyllous leaves arranged spirally.
- ✓ Homosporous, spores produced in sporangia borne on sporophylls.
- ✓ Sporophylls aggregate to form strobili or cones.
- ✓ Found in temperate and tropical forests, especially in moist and shady places.
- ✓ Used in traditional medicine and as spore dust in fireworks and pharmaceuticals.

B. Selaginella (Spike Moss)

- ✓ Small, creeping or sub-erect herbaceous plants.
- ✓ Leaves are microphyllous and bear a ligule at the base.
- ✓ Exhibits heterospory—produces microspores and megaspores in separate sporangia.
- ✓ Sporangia occur on strobili with distinct zones of microsporophylls and megasporophylls.
- ✓ Shows rhizophores, which are specialized organs resembling roots.

- ✓ Some species can undergo poikilohydry (resurrection plants like S. lepidophylla).

C. Equisetum (Horsetail)

- ✓ Living fossil, ancient genus dating back to Paleozoic era.
- ✓ Characterized by jointed stems with distinct nodes and internodes.
- ✓ Leaves are scale-like and arranged in whorls at nodes.
- ✓ Stems are siliceous and photosynthetic.
- ✓ Reproductive organs form a strobilus, composed of sporangiophores bearing sporangia.
- ✓ Spores are homosporous and possess elaters aiding in dispersal.
- ✓ Used in scouring, as herbal medicine, and in traditional remedies.

D. Azolla

- ✓ Small, free-floating aquatic fern.
- ✓ Bilobed leaves, with one lobe floating and the other submerged.
- ✓ Forms a symbiotic relationship with Anabaena azollae, a nitrogen-fixing cyanobacterium.
- ✓ Exhibits heterospory; microspores and megaspores are formed in separate sporangia.
- ✓ Extensively used as biofertilizer in rice paddies (green manure).
- ✓ Multiplies rapidly and covers water surface, inhibiting weed growth.

Heterospory and Seed Habit: -

Heterospory is the condition of producing two distinct types of spores:

- Microspores → Male gametophytes
- Megaspores → Female gametophytes
- Observed in Selaginella, Isoetes, Azolla, and Marsilea.

Important evolutionary significance as:

- Leads to endosporic development of gametophyte.
- Facilitates protection and nourishment of the embryo.
- Leads to reduction in gametophyte size and dependence on the sporophyte.

Seed habit includes:

- Heterospory
- Retention of megaspore within megasporangium
- Development of embryo inside the megaspore wall

- Thus, heterospory is considered a precursor to the evolution of seeds, though Pteridophytes, which do not form true seeds.

Stelar Evolution in Pteridophytes: -

Stele is the central vascular cylinder in stem or root. Evolution of stele reflects adaptations for efficient conduction and support.

Types of Steles:

- ✓ Protostele – Solid core of xylem surrounded by phloem (e.g., Rhynia, Lycopodium)
- ✓ Actinostele – Star-shaped xylem core (e.g., Selaginella)
- ✓ Plectostele – Xylem appears in parallel plates (e.g., Lycopodium clavatum)
- ✓ Siphonostele – Central pith surrounded by xylem and phloem; may be:
- ✓ Ectophloic (phloem outside xylem)
- ✓ Amphiphloic (phloem on both sides)
- ✓ Dictyostele – Stele is dissected into strands (meristeles) by leaf gaps (e.g., Pteris)
- ✓ Polycyclic stele – More than one ring of vascular tissue (e.g., Pteridium)
- ✓ Eustele – Discrete vascular bundles around a pith (found in seed plants)

Economic Importance of Pteridophytes:

- ✓ Soil Conservation: Ferns and lycophytes act as soil binders, prevent erosion (Selaginella).
- ✓ Biofertilizer: Azolla + Anabaena used in rice fields for nitrogen fixation.
- ✓ Medicinal Uses: Equisetum – diuretic, wound healing. Adiantum – used in cough and cold treatment.
- ✓ Ornamental Value: Ferns like Nephrolepis, Adiantum, and Pteris used as indoor and garden plants.
- ✓ Food and Fodder: Young fronds (fiddleheads) of some ferns are edible.
- ✓ Industrial Uses: Spores of Lycopodium used in fireworks, pharmaceuticals, and cosmetics.
- ✓ Ecological Role: Habitat for many insects and small animals.
- ✓ Fossil Fuels: Ancient Pteridophytes contributed to the formation of coal deposits.

103. Pteridophytes are also known as:
a) Gymnosperms
b) Angiosperms
c) Cryptogams
d) Phanerogams

Answer: c) Cryptogams

104. The first seed plant appeared during:
a) Silurian
b) Devonian
c) Cretaceous
d) Carboniferous

Answer: d) Carboniferous

105. Which one of the following eras is regarded as the age of Pteridophytes?
a) Precambrian
b) Cambrian
c) Silurian
d) Corboniferous

Answer: d) Carboniferous

106. Independent alternation of generation is present in:
a) Bryophytes
b) Pteridophytes
c) Gymnosperms
d) Angiosperms

Answer: b) Pteridophytes

107. Prothallus represents the:
a) Sporophytic phase in ferns
b) Gametophytic phase in ferns
c) Sporophytic phase in gymnosperms
d) Gametophytic phase in gymnosperms

Answer: b) Gametophytic phase in ferns

108. If a sporangium is derived from single cell called as:
a) Leptosporangiate fern
b) Eusporangiate fern
c) Heterosporangiate fern
d) None of these

Answer: a) Leptosporangiate fern

109. If a sporangium is derived from a group of cells called as:
a) Leptosporangiate fern
b) Eusporangiate fern
c) Heterosporangiate fern
d) None of these

Answer: b) Eusporangiate fern

110. Eusporangiate mode of sporangium development is found in:

a) Funaria
b) Marchantia
c) Rhynia
d) Lycopodium

Answer: d) Lycopodium

111. Which one of the following doesn't have a pith?
a) Protostele
b) Dictyostele
c) Solenostele
d) Siphonostele

Answer: a) Protostele

112. Vallecular canal and carinal canal are found in the stem of:
a) Selaginella
b) Equisetum
c) Lycopodium
d) None of these

Answer: b) Equisetum

113. Basal swollen part of ligule of Selaginella is:
a) Protonema
b) Hydathodes
c) Rhizopodium
d) Glossopodium

Answer: d) Glossopodium

114. Amphiphloic siphonostele is present in the rhizome of:
a) Selaginella
b) Azolla
c) Marsilea
d) None of these

Answer: c) Marsilea

115. Sperms of Azolla are:
a) Straight multicilliate
b) Straight unicilliate
c) Coiled unicilliate
d) Coiled multicilliate

Answer: d) Coiled multicilliate

116. A stele with pith and phloem layer situated on the outer face of the xylem is called:
a) Amphiphloic siphonostele
b) Ectophloic siphonostele
c) Siphonostele
d) Solenostele

Answer: b) Ectophloic siphonostele

117. The stele having one leaf gap is:
a) Eustele
b) Solenostele
c) Dictyostele
d) Siphonostele

Answer: b) Solenostele

118. The number of neck canal cells in the archegonia of Selaginella is:

a) 8-10
b) 4
c) 1
d) 2

Answer: c) 1

119. The prothallus of fern is:

a) Kidney shaped
b) Heart shaped
c) Flask shaped
d) Club shaped

Answer: b) Heart shaped

120. In ferns, the term 'frond' is given to:
a) Root
b) Sex organs
c) Prothallus
d) Leaves

Answer: d) Leaves

121. Tracheophytes comprise of:
a) Bryophytes, pteridophytes and seed plants
b) Brown algae, bryophytes and pteridophytes
c) Brown algae, pteridophytes and seed plants
d) Pteridophytes and seed plants

Answer: d) Pteridophytes and seed plants

122. Heterospory and ligulate leaves are a feature of:
a) Selaginella
b) Ferns
c) Bryophytes
d) All pteridophytes

Answer: a) Selaginella

123. Smallest pteridophyte is:
a) Wolffia
b) Azolla

c) Zamia pygmea
d) Lycopodium

Answer: b) Azolla

124. Pteridophytes are also known as:
a) Cryptogams without vascular bundles
b) Snakes of the plant kingdom/botanical snakes
c) Vascular cryptogams
d) Both 'b' and 'c'

Answer: d) Both 'b' and 'c'

125. The term 'stele' was first used by:
a) Sachs
b) Kidston and Lang
c) Van Tieghem and Douliot
d) Church

Answer: c) Van Tieghem and Douliot

126. Which pteridophyta group is commonly called club mosses or spike mosess:
a) Psilophyta
b) Lepidophyta
c) Capmophyta
d) Pterophyta

Answer: b) Lepidophyta

127. The most primitive type of stele found in pteridophytes is:
a) Siphonostele
b) Protostele
c) Solenostele
d) Dictyostele

Answer: b) Protostele

128. A rootless, leafless pteridophyte from Rhynichert beds, Abendeenshire, Scottland i.e. Rhynia was discovered by:
a) Sachs
b) Kidston and Lang
c) Van Tieghem and Douliot
d) Church

Answer: b) Kidston and Lang

129. A leafless, colourless, positively geotropic organ that develops from point of bifurcation of stem in Selaginella:

a) Ligule
b) Ramenta
c) Rhizophore
d) Glossopodium

Answer: c) Rhizophore

130. The antherozoids in Selaginella are:

a) Multiflagellated
b) Biflagellated
c) Nonflagellated
d) Uniflagellated

Answer: b) Biflagellated

131. Circinnate vernation in fern referred to:

a) Presence of adventitious roots or rhizome
b) Attachment of sori on leaf surface
c) Leaves are coiled like a spring when young
d) None of these

Answer: c) Leaves are coiled like a spring when young

132. A group of sporangia referred to:

a) Sporophyll
b) Sorus
c) Glossopodium
d) Indusium

Answer: b) Sorus

133. Sex organs are present on which surface of fern prothallus:

a) Ventral
b) Dorsal
c) Both ‘a’ and ‘b’
d) None of these

Answer: a) Ventral

134. Rhizophore of Selaginella is:

a) Organ-sui-generis

b) Leaf

c) Rhizome

d) Stem

Answer: a) *Organ-sui-generis*

135. In ferns, sporangia are borne on the:

a) Margins of leaf

b) Dorsal surface of leaf

c) Ventral surface of leaf

d) Only on the tip of leaf

Answer: c) Ventral surface of leaf

136. Prothallus means:

a) Immature gametophyte

b) Immature sporophyte

c) Immature archegonia

d) None of the above

Answer: a) Immature gametophyte

137. The dominant phase in the life cycle of Pteridophytes is:

a) Gametophyte

b) Sporophyte

c) Zygote

d) Prothallus

Answer: b) Sporophyte

138. The first group of plants to develop vascular tissues (xylem and phloem) are:

a) Bryophytes

b) Pteridophytes

c) Gymnosperms

d) Angiosperms

Answer: b) Pteridophytes

139. In Pteridophytes, spores are produced in:
a) Roots
b) Rhizomes
c) Sporangia
d) Xylem

Answer: c) Sporangia

140. The characteristic mode of reproduction in Pteridophytes is:
a) Vegetative
b) Asexual
c) Sexual and asexual
d) None of the above

Answer: c) Sexual and asexual

141. Rhynia is a member of which extinct group of Pteridophytes?
a) Psilophyta
b) Lycophyta
c) Sphenophyta
d) Pterophyta

Answer: a) Psilophyta

142. Rhynia is considered important because it represents:
a) The first gymnosperm
b) The first seed plant
c) An early vascular plant
d) An angiosperm ancestor

Answer: c) An early vascular plant

143. The vascular tissue of Rhynia is:
a) Endarch
b) Exarch
c) Mesarch
d) Polyarch

Answer: b) Exarch

144. The reproduction in Rhynia occurs through:
a) Seeds
b) Flowers
c) Spores
d) Vegetative propagation

Answer: c) Spores

145. The fossilized remains of Rhynia were first discovered in:
a) India
b) Scotland
c) USA
d) China

Answer: b) Scotland

146. Lycopodium belongs to which class of Pteridophytes?
a) Psilopsida
b) Lycopsida
c) Sphenopsida
d) Pteropsida

Answer: b) Lycopsida

147. The leaves of Lycopodium are:
a) Megaphyllous
b) Microphyllous
c) Scale leaves
d) Pinnately compound

Answer: b) Microphyllous

148. The reproductive structures in Lycopodium are called:
a) Strobili
b) Cones
c) Flowers
d) Bulbils

Answer: a) Strobili

149. Which type of spore production is seen in Lycopodium?
a) Heterospory
b) Homospory
c) Both (a) and (b)
d) None of these

Answer: b) Homospory

150. The prothallus of Lycopodium is:
a) Epiphytic
b) Saprophytic
c) Parasitic
d) Aerial

Answer: b) Saprophytic

151. Selaginella is known for exhibiting:
a) Homospory
b) Heterospory
c) Isogamy
d) Oogamy

Answer: b) Heterospory

152. The primary function of ligule in Selaginella is:
a) Photosynthesis
b) Water absorption
c) Protection
d) Mechanical support

Answer: b) Water absorption

153. Which of the following species of Selaginella is known as the "resurrection plant"?
a) S. kraussiana
b) S. rupestris
c) S. lepidophylla
d) S. selaginoides

Answer: c) S. lepidophylla

154. Selaginella differs from Lycopodium in having:
a) Microphylls
b) Xylem tracheids
c) Heterospory
d) Rhizoids

Answer: c) Heterospory

155. The strobili in Selaginella bear:
a) Only microsporangia
b) Only megasporangia
c) Both microsporangia and megasporangia
d) None of the above

Answer: c) Both microsporangia and megasporangia

156. Equisetum is commonly known as:
a) Club moss
b) Horsetail
c) Fern
d) Liverwort

Answer: b) Horsetail

157. The stem of Equisetum is:
a) Hollow and ribbed
b) Solid and smooth
c) Woody
d) Fleshy

Answer: a) Hollow and ribbed

158. The silica deposition in Equisetum is mainly found in:
a) Roots
b) Stems
c) Leaves
d) Spores

Answer: b) Stems

159. The reproductive structures of Equisetum are borne in:
a) Cones
b) Strobili
c) Sporocarps
d) Spathes

Answer: b) Strobili

160. Equisetum is used for:
a) Making dyes
b) Treating kidney problems
c) Wood production
d) Oil extraction

Answer: b) Treating kidney problems

161. Heterospory is the production of:
a) Only megaspores
b) Only microspores
c) Both microspores and megaspores
d) No spores

Answer: c) Both microspores and megaspores

162. Seed habit originated due to:
a) Homospory
b) Heterospory
c) Rhizoids
d) Bryophytes

Answer: b) Heterospory

163. Which is the most primitive type of stele?
a) Protostele
b) Siphonostele
c) Dictyostele
d) Eustele

Answer: a) Protostele

164. Equisetum is used in:
a) Scouring metal
b) Producing antibiotics
c) Textile industry
d) Food industry

Answer: a) Scouring metal

165. Azolla is important because it:
a) Fixes atmospheric nitrogen
b) Produces seeds
c) Is used as timber
d) None of the above

Answer: a) Fixes atmospheric nitrogen

166. Which of the following Pteridophytes exhibit heterospory?
a) Lycopodium
b) Selaginella
c) Equisetum
d) Adiantum

Answer: b) Selaginella

167. The significance of heterospory in the evolution of seed habit is:
a) It leads to the development of unisexual gametophytes
b) It promotes cross-fertilization
c) It reduces dependence on water for fertilization
d) All of the above

Answer: d) All of the above

168. The female gametophyte in heterosporous Pteridophytes is:
a) Free-living
b) Enclosed within the megaspore wall
c) A sporophyte
d) Photosynthetic

Answer: b) Enclosed within the megaspore wall

169. The retention of megaspore within the megasporangium leads to:
a) Reduction of gametophyte
b) Formation of seeds
c) Dependence on sporophyte
d) All of the above

Answer: d) All of the above

170. The most advanced type of stele in Pteridophytes is:
a) Protostele
b) Solenostele
c) Eustele
d) Polycyclic stele

Answer: c) Eustele

171. A siphonostele differs from a protostele in having:
a) A central pith
b) Radial vascular bundles
c) No phloem
d) Secondary growth

Answer: a) A central pith

172. In dictyostele, the vascular tissue is arranged in:
a) A continuous ring
b) Separate meristeles
c) A scattered manner
d) A single strand

Answer: b) Separate meristeles

173. Amphiphloic siphonostele is characterized by:
a) Xylem surrounded by phloem on both sides
b) Phloem only on the outer side
c) Xylem without phloem
d) Absence of pith

Answer: a) Xylem surrounded by phloem on both sides

174. Which type of stele is found in Selaginella?

a) Protostele
b) Siphonostele
c) Eustele
d) Atactostele

Answer: a) Protostele

175. Azolla is symbiotically associated with which nitrogen-fixing cyanobacterium?

a) Nostoc
b) Anabaena
c) Oscillatoria
d) Rivularia

Answer: b) Anabaena

176. The primary agricultural importance of Azolla is:

a) Enhancing soil fertility
b) Weed control
c) Pest resistance
d) Increasing seed production

Answer: a) Enhancing soil fertility

177. Azolla is commonly used as biofertilizer in:

a) Wheat fields
b) Rice fields
c) Tea plantations
d) Cotton farms

Answer: b) Rice fields

178. Azolla is referred to as "green manure" because:

a) It decomposes quickly and releases nutrients
b) It produces flowers and seeds
c) It absorbs toxic metals
d) It prevents soil erosion

Answer: a) It decomposes quickly and releases nutrients

179. Which Pteridophyte is commonly used as an ornamental plant?
a) Marsilea
b) Adiantum
c) Selaginella
d) Rhynia

Answer: b) Adiantum

180. Which Pteridophyte is used in the treatment of respiratory disorders?
a) Lycopodium
b) Equisetum
c) Azolla
d) Psilotum

Answer: b) Equisetum

181. Lycopodium spores are used in:
a) Explosives
b) Pharmaceuticals
c) Lubricants
d) All of the above

Answer: d) All of the above

182. Which of the following is used for scouring metal surfaces?
a) Lycopodium
b) Equisetum
c) Azolla
d) Selaginella

Answer: b) Equisetum

183. Which Pteridophyte is a rich source of flavonoids and is used in herbal medicine?
a) Adiantum
b) Selaginella
c) Lycopodium
d) Equisetum

Answer: a) Adiantum

184. Dryopteris is used in medicine for treating:

a) Kidney stones
b) Intestinal worms
c) Liver diseases
d) Heart diseases

Answer: b) Intestinal worms

185. Pteridophytes are ecologically important because they:

a) Act as soil binders
b) Help in nitrogen fixation
c) Provide habitat for insects
d) All of the above

Answer: d) All of the above

UNIT-III: Gymnosperms

Classification of Gymnosperms (Simplified Phylogenetic Overview): -

- ✓ Kingdom: Plantae
- ✓ Subkingdom: Embryophyta
- ✓ Division: Gymnospermae (Naked seed plants)

Modern classification as per Sporne (1965)

Division: Gymnospermae

Class I: Cycadopsida

Primitive gymnosperms with palm-like appearance and unbranched stems; leaves pinnate; circinate vernation present; coralloid roots.

Order 1: Cycadales

- Family: Cycadaceae, e.g., Cycas

Class II: Coniferopsida

Most advanced group of gymnosperms; generally evergreen trees or shrubs; leaves needle- or scale-like; cones present.

Order 1: Coniferales

- Family: Pinaceae – e.g., Pinus
- Family: Cupressaceae – e.g., Cupressus
- Family: Taxodiaceae – e.g., Taxodium
- Family: Araucariaceae – e.g., Araucaria
- Family: Podocarpaceae – e.g., Podocarpus
- Family: Cephalotaxaceae – e.g., Cephalotaxus
- Family: Taxaceae – e.g., Taxus

Class III: Ginkgoopsida

Only one living species remains; considered a "living fossil"; fan-shaped leaves; motile sperm.

Order: Ginkgoales

- Family: Ginkgoaceae, e.g., Ginkgo biloba

Class IV: Gnetopsida

Advanced gymnosperms with angiosperm-like features; vessels in xylem; double fertilization (in some); opposite leaves.

Order 1: Gnetales

- Family: Gnetaceae – e.g., Gnetum
- Family: Ephedraceae – e.g., Ephedra
- Family: Welwitschiaceae – e.g., Welwitschia

Distribution: -

- ✓ Cycadales are confined to tropical and subtropical zones (India, Africa, South East Asia, Australia).
- ✓ Coniferales dominate the temperate and alpine zones, forming vast forests (taiga biome).
- ✓ Ginkgoales now include only one species (Ginkgo biloba), native to China, cultivated worldwide.
- ✓ Gnetales are found in arid regions (e.g., Ephedra) and tropical rainforests (Gnetum).

Salient Features of Major Gymnosperm Orders: -

A. Order: Cycadales

Morphology

- Palm-like appearance; mostly unbranched stems.
- Long, pinnately compound, spirally arranged leaves with circinate vernation.
- Persistent leaf bases give a rugged appearance to the stem.

Anatomy

Stem:

- Large cortex and pith, broad vascular cylinder.
- Manoxylic wood (soft and parenchymatous with large pith).
- Girdling leaf traces – a unique feature.

Leaves:

- Mesophyll differentiated into palisade and spongy tissue.
- Midrib with transfusion tissue.

Roots:

- Tap root and coralloid roots (dichotomously branched) housing cyanobacteria (Nostoc, Anabaena) for nitrogen fixation.

Reproduction

Dioecious: Male and female plants separate.

Male strobilus (cone):

- Compact, bearing microsporophylls spirally with microsporangia.
- Pollen grains released through longitudinal slits.

Female structures:

- No true cone; megaspore-bearing megasporophylls are leaf-like and loosely arranged.

Ovules:

- Large, orthotropous, with 3-layered integument.
- Pollination by wind (anemophily).
- Sperm: Multiciliate, motile (a primitive character).

B. Order: Ginkgoales

Morphology

- Only living species: Ginkgo biloba ("living fossil").
- Tall deciduous tree with fan-shaped, bilobed leaves.
- Leaves with dichotomous venation.

Anatomy

- Wood like conifers: pycnoxylic, composed of tracheids and rays.
- Mucilage canals in leaf mesophyll and cortex.
- No vessels; only tracheids.

Reproduction

Dioecious.

- **Male plant:** Catkin-like strobili with microsporophylls bearing two microsporangia.
- **Female plant:** Ovules borne in pairs on stalks.
- Fertilization by multiflagellate motile sperms.
- **Seeds:** Large with fleshy sarcotesta (outer seed coat).

C. Order: Coniferales

Morphology

- Evergreen, tall trees with needle-like or scale-like leaves.
- Dimorphic branches: long shoots and dwarf shoots (e.g., in Pinus).
- Thick bark and conical growth habit.

Anatomy

Stem:

- Secondary growth extensive; wood is pycnoxylic (compact).

- Contains tracheids with bordered pits and resin ducts.

Leaves:

- Needle-shaped with thick cuticle and sunken stomata.
- Mesophyll with transfusion tissue and resin ducts.

Roots:

- Tap root with lateral branching.
- Mycorrhizal association common.

Reproduction

- Monoecious: Male and female cones on same plant.
- Male cone: Small, bears microsporophylls with two microsporangia.
- Female cone: Large, compound; each cone scale has two ovules.
- Pollen grains with air bladders (wings) for wind dispersal.
- Seeds are winged, non-endospermic, and dispersed by wind.

D. Order: Gnetales

Morphology

- Highly diverse:
- Ephedra: jointed stemmed xerophyte.
- Gnetum: climber with broad leaves.
- Welwitschia: two long persistent leaves.
- Resemble angiosperms in several traits.

Anatomy

- Xylem contains vessels (unique among gymnosperms).
- Phloem with companion-like cells.
- Reticulate venation in leaves (Gnetum).

Reproduction

- Mostly dioecious.
- Strobili may be compound, sometimes resembling angiosperm flowers.
- Ovules have double integuments (angiosperm-like).
- No archegonium in Gnetum and Welwitschia.
- Some show a form of double fertilization, though without endosperm.

General Accounts of Selected Genera: -

A. Cycas

- Habit and Habitat

Palm-like dioecious plant of tropical and subtropical regions.

- Anatomy
  - Stem: Manoxylic wood, girdling leaf traces, mucilage canals.
  - Leaves: Thick cuticle, transfusion tissue, circinate vernation.
  - Roots: Normal tap root and coralloid roots with cyanobacteria.

- Reproductive Features

  - Dioecious.
  - Male cones large and compact.
  - Female megasporophylls are leaf-like, loosely arranged.
  - Ovules orthotropous, with 3-layered integument.
  - Sperms large, spirally coiled and motile.
  - Seeds are large and fleshy.

B. Pinus

- Habit and Habitat

Tall coniferous tree of temperate and subalpine regions.

- Anatomy
  - Stem: Pycnoxylic wood, resin ducts, bordered pits.
  - Leaves: Xeromorphic adaptations – thick cuticle, sunken stomata, hypodermis.
  - Roots: Tap root with ectomycorrhizal fungi.

- Reproductive Features

  - Monoecious.
  - Male cones with microsporangia on microsporophylls; pollen with wings.

  - Female cones large; ovuliferous scales each bearing two ovules.
  - Fertilization occurs in the second year.
  - Winged seeds for anemophily.

C. Ephedra

- Habit and Habitat

Small, xerophytic, jointed-stem shrub found in dry regions of Asia, including Himalayas.

- Anatomy
  - Stem: Green, photosynthetic, with ridges and grooves.
  - Leaves: Opposite, scale-like.
  - Xylem with vessels (advanced feature).

- Reproductive Features

- Dioecious.
- Strobili borne in axils of scale leaves.
- Male cone with stalked microsporangiophores.
- Female cone with ovules covered by envelope-like bracts.
- Ephedrine, a valuable alkaloid, is extracted for medicinal use.

Economic Importance of Gymnosperms: -

- ✓ Timber: Pinus, Cedrus, Abies – light, durable wood for construction.
- ✓ Pulp and Paper: Pinus wood used in paper manufacturing.
- ✓ Resins and Oils: Pinus – turpentine and resin in varnish, adhesives.
- ✓ Medicinal: Ephedra (ephedrine), Taxus (taxol – anticancer).
- ✓ Ornamental Plants: Cycas, Ginkgo, Araucaria used in landscaping.
- ✓ Edible Seeds and Sago: Pinus gerardiana (Chilgoza), Cycas revoluta (sago).
- ✓ Ecological Role: Soil binding, carbon sequestration, shelter in forests.

186. Gymnosperms are characterized by:
a) Enclosed ovules
b) Naked ovules
c) Fruits with seeds
d) Double fertilization

Answer: b) Naked ovules

187. Gymnosperms belong to which plant group?
a) Angiosperms
b) Bryophytes
c) Pteridophytes
d) Spermatophytes

Answer: d) Spermatophytes

188. The smallest gymnosperm is:
a) Ephedra triandra
b) Thuja orientalis
c) Zamia pygmia
d) Microcycas calocapa

Answer: c) Zamia pygmia

189. In which of the following vessels are found:
a) Ephedra
b) Cycas
c) Pinus
d) Lycopodium

Answer: a) Ephedra

190. The endosperm in gymnosperms is formed by:
a) Fusion of one male gamete and one polar nucleus
b) Fusion of two polar nuclei and one male gamete
c) Fertilized egg
d) From megaspore

Answer: d) From megaspore

191. Winged pollen grains are found in:
a) Coniferales
b) Cycadales
c) Taxales
d) Gnetales

Answer: a) Coniferales

192. The largest spermatozoids are present in:
a) Cycadales
b) Coniferales
c) Gnetales
d) Ginkgoales

Answer: a) Cycadales

193. Diploxylic vascular bundle is found in:
a) Cycas leaves
b) Cycas roots
c) Pinus needles
d) Pinus leaves

Answer: a) Cycas leaves

194. How many living species of Cycas are found in India?
a) 10
b) 8
c) 6
d) 14

Answer: c) 14

195. Coralloid root of Cycas contains:
a) Red algae
b) Brown algae
c) Fungi
d) Blue green algae

Answer: d) Blue green algae

196. The largest archegonium is found in which member of Gymnosperm:
a) Pinus
b) Gnetum
c) Ephedra
d) Cycas

Answer: d) Cycas

197. The largest size of male gamete is found in:
a) Cycas
b) Pinus
c) Ephedra
d) Gnetum

Answer: a) Cycas

198. Winged seeds are found in:
a) Cycas
b) Pinus
c) Ephedra
d) Gnetum

Answer: b) Pinus

199. The wings on the seed of Pinus are developed from:
a) Integuments
b) Nucellus
c) Ovuliferous scale
d) Carpellary scale

Answer: c) Ovuliferous scale

200. The ovuliferous scale (bract scale) of Pinus is a part of:
a) Megasporophyll
b) Microsporophyll
c) Ovule
d) Dwarf shoot

Answer: a) Megasporophyll

201. Turpentine oil is obtained from:
a) Pinus gerardiana
b) Pinus roxburghii
c) Pinus longifolia
d) Pinus excela

Answer: b) Pinus roxburghii

202. An important characteristic feature of the wood of Pinus is the presence of bars of Sanio. Those bars are formed by deposition of:

a) Cellulose and terpenes
b) Cellulose and pectin
c) Pectin and tannins
d) Lignin and resin

Answer: b) Cellulose and pectin

203. Shower of sulfur occurs due to:
a) Reaction of SO_2 with water during rain forming H_2SO_4
b) Release of sulfur-rich pollutants from oil refineries
c) Mass release of microspores of Cycas
d) Mass release of microspores of Pinus

Answer: d) Mass release of microspores of Pinus

204. Girdling leaf traces are the characteristic feature of:
a) Cycas
b) Pinus
c) Ephedra
d) Gnetum

Answer: a) Cycas

205. Sago palm is:
a) Cycas circinalis
b) Cycas revoluta
c) Areca catechu
d) Ginkgo

Answer: b) Cycas revoluta

206. The anti-cancer drug is obtained from:
a) Cycas
b) Pinus
c) Taxus
d) Gnetum

Answer: c) Taxus

207. The dry fruit 'Chilgoza' is obtained from:
a) Pinus gerardiana
b) Pinus roxburghii
c) Cycas circinalis
d) Prunus cerasus

Answer: a) Pinus gerardiana

208. Mono, Bi, Tri, Tetra and Penta foliar spurs occur in:
a) Cycas
b) Pinus
c) Taxus
d) Gnetum

Answer: b) Pinus

209. Cycas ovule is:
a) Campylotropous
b) Hemianatropous
c) Orthotropous
d) Anatropous

Answer: c) Orthotropous

210. The sperms of Cycas are:
a) Very large and have numerous spirally arranged cilia
b) Very small and have two flagella
c) Large and non-motile
d) Small and non-motile

Answer: a) Very large and have numerous spirally arranged cilia

211. The number of neck canal cells in the archegonium of Cycas is:
a) 0
b) 2
c) 4
d) 6

Answer: a) 0

212. Cycas is said to be living fossil because it:
a) Is found only in China
b) Looks like a tree fern
c) Also occurs as a fossil
d) Has ciliated sperms

Answer: d) Has ciliated sperms

213. In gymnosperms, archegonia lack:

a) Egg cell
b) Neck canal cell
c) Neck cells
d) Venter canal cell

Answer: b) Neck canal cell

214. From which part of Ephedra plant, the drug ephedrine is obtained:

a) Root
b) Stem
c) Leaves
d) Flower

Answer: b) Stem

215. Who defined gymnosperms as 'phanerogams without ovary'?

a) Goebel
b) Theophrastus
c) Campbell
d) None of the above

Answer: a) Goebel

216. In Pinus, the dwarf shoot with needle is called:

a) Chir
b) Spur
c) Cataphylls
d) Saccus

Answer: b) Spur

217. The microspores are liberated in gymnosperms at various stages of development of male gametophyte; they are liberated at 3-celled stage, 4-celled stage and 5-celled stage, respectively in:

a) Cycas, Pinus, Ephedra
b) Pinus, Ephedra, Cycas
c) Cycas, Ephedra, Gnetum
d) Gnetum, Ephedra, Pinus

Answer: a) Cycas, Pinus, Ephedra

218. Simple polyembryony is found in:
a) Cycas and Pinus both
b) Cycas
c) Pinus
d) Absent in both

Answer: a) Cycas and Pinus both

219. Desire type of Cycas can be grown by:
a) Spores
b) Bulbils
c) Seeds
d) Ovules

Answer: b) Bulbils

220. The leaf of Cycas shows:
a) Xerophytic characters
b) Hydrophytic characters
c) Mesophytic characters
d) Lithophytic characters

Answer: a) Xerophytic characters

221. Conifers occur in:
a) Arid areas
b) Tropical areas
c) Temperate climate
d) All of these

Answer: c) Temperate climate

222. Inverted omega-shaped arrangement of vascular bundles is found in:
a) Cycas rachis
b) Cycas leaflet
c) Cycas stem
d) Cycas root

Answer: b) Cycas leaflet

223. In gymnosperms, pollen drop is:

a) Secretion of nucellus
b) Pollen dropped by wind
c) Water drop
d) None of these

Answer: a) Secretion of nucellus

224. 'Canada balsam' is obtained from:
a) Pinus
b) Cedrus
c) Abies
d) Cupressus

Answer: c) Abies

225. Cedar wood oil is obtained from the heart wood of:
a) Thuja
b) Angiosperms
c) Cedrus
d) Juniperus virginiana

Answer: d) Juniperus virginiana

226. Which wood is used for making pencils?
a) Juniperus
b) Cedrus
c) Abies
d) Pinus

Answer: a) Juniperus

227. In gymnosperms, the seeds are naked because the lack of:
a) Integument
b) Nucellus
c) Pericarp
d) Perianth

Answer: c) Pericarp

228. The fossil resin (Amber) is obtained from:
a) Pinus succinifera
b) Pinus gerardiana
c) Pinus excels
d) Pinus marittiana

Answer: a) Pinus succinifera

229. Which of the following is NOT a major order of gymnosperms?
a) Cycadales
b) Coniferales
c) Ginkgoales
d) Poales

Answer: d) Poales

230. Which gymnosperm order has only one extant (living) species?
a) Cycadales
b) Ginkgoales
c) Coniferales
d) Gnetales

Answer: b) Ginkgoales

231. The majority of gymnosperms are found in:
a) Deserts
b) Tropical forests
c) Cold and temperate regions
d) Wetlands

Answer: c) Cold and temperate regions

232. Which gymnosperm group is considered the most primitive?
a) Ginkgoales
b) Cycadales
c) Coniferales
d) Gnetales

Answer: b) Cycadales

233. Gymnosperms were dominant during which geological era?
a) Mesozoic
b) Cenozoic

c) Paleozoic
d) Precambrian

Answer: a) Mesozoic

234. The fossilized gymnosperm genus "Cordaites" belongs to:
a) Cycadales
b) Gnetales
c) Coniferales
d) Pteridosperms

Answer: d) Pteridosperms

235. The dominant trees in boreal (taiga) forests belong to which gymnosperm order?
a) Cycadales
b) Gnetales
c) Coniferales
d) Ginkgoales

Answer: c) Coniferales

236. Which feature is common in all gymnosperms?
a) Flowers
b) Fruits
c) Seeds without ovary wall
d) Tracheids and sieve tubes

Answer: c) Seeds without ovary wall

237. Cycadales are commonly referred to as:
a) Cone-bearing plants
b) Living fossils
c) Flowering plants
d) Fern allies

Answer: b) Living fossils

238. Which among the following genera belongs to Cycadales?
a) Cycas
b) Pinus
c) Ephedra
d) Ginkgo

Answer: a) Cycas

239. The leaves of Cycas resemble:
a) Mosses
b) Ferns
c) Orchids
d) Grasses

Answer: b) Ferns

240. Which is NOT a characteristic of Cycadales?
a) Dioecious nature
b) Pinnate leaves
c) Vessels in xylem
d) Presence of cones

Answer: c) Vessels in xylem

241. Ginkgo biloba is also known as:
a) Indian pine
b) Maidenhair tree
c) Desert shrub
d) Palm tree

Answer: b) Maidenhair tree

242. The leaves of Ginkgo are:
a) Pinnate
b) Needles
c) Fan-shaped
d) Simple and entire

Answer: c) Fan-shaped

243. Ginkgo biloba seeds are covered by:
a) A fruit-like fleshy coat
b) A true fruit
c) A dry capsule
d) A hard nut shell

Answer: a) A fruit-like fleshy coat

244. Which of the following is true about Ginkgo biloba?
a) It is dioecious
b) It has no medicinal uses
c) It reproduces only by spores
d) It is extinct in the wild

Answer: a) It is dioecious

245. Ginkgo is considered a "living fossil" because:
a) It has changed very little over millions of years
b) It reproduces by spores
c) It is found only in fossils
d) It has no economic importance

Answer: a) It has changed very little over millions of years

246. The order Gnetales includes:
a) Cycas
b) Ginkgo
c) Ephedra
d) Cedrus

Answer: c) Ephedra

247. Ephedra is known for producing:
a) Antioxidants
b) Ephedrine alkaloid
c) Latex
d) Essential oils

Answer: b) Ephedrine alkaloid

248. Gnetales are unique among gymnosperms because they have:
a) Double fertilization
b) Flowers
c) No vascular tissues
d) Free-living gametophytes

Answer: a) Double fertilization

249. Which is a characteristic feature of Gnetales?
a) Needle-like leaves
b) Presence of vessel elements in xylem
c) Rhizoids instead of roots
d) Fronds like ferns

Answer: b) Presence of vessel elements in xylem

250. Coniferales include:
a) Cycas
b) Ginkgo
c) Pinus

d) Ephedra

Answer: c) Pinus

251. The wood of conifers is primarily composed of:
a) Vessels
b) Tracheids
c) Fibers
d) Parenchyma only

Answer: b) Tracheids

252. Cycas is often referred to as:
a) Maidenhair tree
b) Sago palm
c) Paper pine
d) Desert fern

Answer: b) Sago palm

253. Which of the following structures in Cycas contains motile sperms?
a) Megaspore
b) Pollen grain
c) Microsporangium
d) Male gametophyte

Answer: d) Male gametophyte

254. The stem of Cycas is characterized by:
a) Aerial and branched structure
b) Underground rhizome-like growth
c) Thick cortex with mucilage canals
d) Presence of resin canals

Answer: c) Thick cortex with mucilage canals

255. In Cycas, coralloid roots are associated with:
a) Phosphate absorption
b) Nitrogen fixation
c) Water storage
d) Mycorrhizal association

Answer: b) Nitrogen fixation

256. The megasporophylls of Cycas resemble:
a) Cones
b) Leaves
c) Flowers
d) Fern fronds

Answer: b) Leaves

257. Pinus belongs to which order?
a) Cycadales
b) Gnetales
c) Coniferales
d) Ginkgoales

Answer: c) Coniferales

258. The leaves of Pinus are:
a) Broad and fan-shaped
b) Needle-like and arranged in fascicles
c) Compound and pinnate
d) Oppositely arranged

Answer: b) Needle-like and arranged in fascicles

259. Resin ducts in Pinus help in:
a) Water absorption
b) Transport of nutrients
c) Defense against pathogens
d) Formation of pollen grains

Answer: c) Defense against pathogens

260. In Pinus, the male cone produces:
a) Ovaries
b) Megasporophylls
c) Pollen grains
d) Ovules

Answer: c) Pollen grains

261. The type of wood found in Pinus is:
a) Hard wood
b) Porous wood
c) Soft wood
d) Mixed wood

Answer: c) Soft wood

262. The pollen grains of Pinus possess:
a) Wings and air sacs
b) Flagella
c) Air sacs
d) Wings

Answer: a) Wings and air sacs

263. Ephedra is commonly found in:
a) Tropical rainforests
b) Coastal regions
c) Arid and semi-arid regions
d) Alpine meadows

Answer: c) Arid and semi-arid regions

264. Which of the following gymnosperms contains ephedrine alkaloid?
a) Pinus
b) Ginkgo
c) Cycas
d) Ephedra

Answer: d) Ephedra

265. Ephedra is unique among gymnosperms due to its:
a) Presence of vessel elements
b) Absence of cones
c) Large ovules
d) Retention of primitive vascular tissues

Answer: a) Presence of vessel elements

266. The leaves of Ephedra are:
a) Broad and ovate
b) Scale-like and reduced
c) Compound and pinnate
d) Needle-like

Answer: b) Scale-like and reduced

267. Which gymnosperm is used in making turpentine oil?
a) Cycas
b) Pinus
c) Ephedra

d) Ginkgo

Answer: b) Pinus

268. The drug "ephedrine" derived from Ephedra is used for:
a) Treating malaria
b) Relieving respiratory disorders
c) Reducing blood sugar levels
d) Controlling blood pressure

Answer: b) Relieving respiratory disorders

269. The seeds of Ginkgo biloba are used in:
a) Paper production
b) Traditional medicine
c) Textile dyeing
d) Construction

Answer: b) Traditional medicine

270. Conifers are an important source of:
a) Rubber
b) Wood pulp for paper industry
c) Essential oils
d) Both (b) and (c)

Answer: d) Both (b) and (c)

271. The gymnosperm used as an ornamental plant due to its attractive leaves is:
a) Pinus
b) Cycas
c) Ginkgo
d) Ephedra

Answer: c) Ginkgo

272. Which gymnosperm is commonly used in landscaping and bonsai?
a) Cycas
b) Ginkgo
c) Pinus
d) Ephedra

Answer: a) Cycas

273. The main economic product obtained from conifers is:
a) Latex

b) Resin
c) Edible seeds
d) Essential oils

Answer: b) Resin

274. Gymnosperms are important in carbon sequestration because:
a) They fix nitrogen
b) They absorb carbon dioxide efficiently
c) They release oxygen at night
d) They have no role in carbon sequestration

Answer: b) They absorb carbon dioxide efficiently

UNIT-IV: Palaeobotany

General Account of Cycadofilicales, Bennettitales, and Cordaitales:-

A. Cycadofilicales (Pteridosperms or Seed Ferns)

- ✓ Geological Period: Devonian to Permian (approx. 360–250 million years ago)
- ✓ General Characteristics:
  - Extinct group of gymnospermous plants with fern-like appearance, hence the name Pteridosperms (pteridophyte + spermatophyte).
  - Exhibited fern-like foliage, but reproduced via seeds, not spores.
  - Leaves were compound, resembling true ferns (e.g., Alethopteris, Pecopteris).
- ✓ Vascular system: Often polystelic with mesarch or centrarch xylem.
- ✓ Reproductive structures:
  - Ovules borne on foliage, often on modified pinnules.
  - Male structures: Pollen sacs (sporangia) attached to microsporophylls.
  - Heterosporous: Produced megaspores (in ovules) and microspores (pollen).
  - Gametophytes: Retained features of both seed plants and ferns.
- ✓ Evolutionary Significance:
  - Represent a transitional group between ferns and seed plants.
  - Help understand the origin of seeds and evolution of gymnospermy.
- ✓ Fossil examples: Lyginopteris, Medullosa, Calymatotheca.

B. Bennettitales (Cycadeoideales)

- ✓ Geological Period: Triassic to Cretaceous (approx. 250–65 million years ago)
- ✓ Morphological Features:
  - Small to medium-sized, woody, palm-like or cycad-like plants.
  - Had unbranched or branched stems with crown of pinnately compound leaves.
  - Leaves with thick cuticle and sunken stomata; xerophytic adaptations.
- ✓ Stems: Thick with well-developed cortex and central vascular cylinder (pycnoxylic wood).
- ✓ Reproductive Features:
  - Reproduction via complex, bisexual or unisexual cones (flower-like structures).
  - Ovules and microsporangia enclosed in a flower-like receptacle.

- Some Bennettitalean structures resemble modern angiosperm flowers.
- Pollination likely entomophilous (insect-assisted), suggesting evolutionary advancement.

✓ Fossil Genera: Williamsonia (elongated receptacle), Cycadeoidea (embedded reproductive organs).

✓ Evolutionary Significance:
- Some botanists hypothesize a relationship between Bennettitales and Angiosperms due to flower-like structures.
- Provide insights into pre-angiosperm reproductive evolution.

C. Cordaitales

✓ Geological Period: Late Carboniferous to Permian (approx. 300–250 million years ago)

✓ General Characteristics:
- Large, tree-like gymnosperms, up to 30 meters tall.
- Leaves were long, narrow, strap-shaped, arranged spirally on branches.

✓ Vascular system: Endarch xylem; stems with large pith, thick cortex.

✓ Reproductive Features:
- Reproduction via unisexual cones (strobili): male and female cones separate.
- Ovules borne on bracts; each cone had spirally arranged sporophylls.
- Pollen grains were monosaccate (one air sac) or bisaccate.

✓ Fossil Genera: Cordaites, Mesoxylon, Cordaicladus.

✓ Evolutionary Importance:
- Considered the precursors of modern conifers.
- Advanced vascular tissue and cone morphology.

Geological Time Scale (GTS): -

A chronological framework that classifies Earth's 4.6-billion-year history into hierarchical units based on major evolutionary, climatic, and geological events.

Hierarchical Divisions:

Eon (largest unit)

- ✓ Precambrian (Archean + Proterozoic): ~88% of Earth's history; life mostly microbial.
- ✓ Phanerozoic (Visible life): Last 541 million years; fossil-rich.

Eras (within Phanerozoic):

- Paleozoic (541–252 Ma):
  - ➢ "Age of Invertebrates and Early Plants"
  - ➢ Colonization of land, early vascular plants, gymnosperms.
- Mesozoic (252–66 Ma):
  - ➢ "Age of Gymnosperms and Reptiles"
  - ➢ Dominance of Cycads, Conifers, and later flowering plants.
- Cenozoic (66 Ma–present):
  - ➢ "Age of Mammals and Angiosperms"

Fossilization Process & Types of Fossils: -

Process of Fossilization (Taphonomy):

- ✓ Death and Rapid Burial: To avoid decomposition.
- ✓ Decay of Soft Parts: Only hard tissues (wood, seeds, bones) likely preserved.
- ✓ Permineralization: Infiltration of mineral-rich water into cells (e.g., silica, calcite).
- ✓ Compression/Carbonization: Leaves a carbon-rich film.
- ✓ Replacement: Original material replaced molecule by molecule (e.g., petrified wood).
- ✓ Mold and Cast Formation: External and internal impressions of parts.
- ✓ Preservation in Resin or Ice: Preserves whole organisms (rare).

Types of Fossils: -

- ✓ Compression Fossils: Flattened remains, often leaves with organic matter.
- ✓ Impression Fossils: Negative imprints of external surfaces without organic matter.
- ✓ Petrified (Permineralized) Fossils: Cell walls replaced with minerals.
- ✓ Cast Fossils: 3D structures formed from infilled molds.
- ✓ Amber Fossils: Insects or plant parts preserved in tree resin.
- ✓ Coprolites: Fossilized feces, indicating diet.
- ✓ Coal Balls: Carbonate nodules in coal seams preserving plant tissues.

Techniques for Fossil Study: -

- ✓ *Maceration:* Softening and disintegration of matrix to isolate fossilized tissues. Used for spores, cuticles, etc.
- ✓ *Peel Technique:* Surface etched with acid, coated with cellulose acetate, peeled off for microscope viewing. Useful in petrified woods.
- ✓ *Thin Sectioning:* Fossils embedded in resin and sliced into thin sections for microscopy.
- ✓ *Scanning Electron Microscopy (SEM):* High-resolution surface imaging for fine structural details.
- ✓ *Radiometric Dating:* Isotopic analysis (e.g., U-Pb, K-Ar, C-14) for fossil age estimation.
- ✓ *CT Scanning & 3D Imaging:* Non-destructive method to view internal structures digitally.

Contribution of Birbal Sahni: -

- ✓ *Founder of Indian Paleobotany:* Established the Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow in 1946.
  - Focused on fossil plants from Gondwana and Deccan Intertrappean Beds.
- ✓ *Discovery of Pentoxylon:*
  - A unique fossil gymnosperm with characters of cycads and conifers.
  - Opened new insights into gymnosperm evolution.
- ✓ *Advancement of Stratigraphic Correlation:*
  - Used plant fossils to correlate strata across India and abroad.
- ✓ *Integration of Botany and Geology:*
  - Pioneered multidisciplinary paleobotanical research.
  - Recognized the paleoclimatic and paleoenvironmental significance of fossil plants.
- ✓ First botanist in India to be elected Fellow of the Royal Society (FRS) (1936).
- ✓ Indian government issued a postal stamp in his honor (1972).

275. Cycadofilicales are also known as:
a) Seed Ferns
b) True Ferns
c) Gymnosperms
d) Angiosperms

Answer: a) Seed Ferns

276. Which of the following is a characteristic feature of Cycadofilicales?
a) Presence of compound leaves
b) Production of ovules on leaf-like structures
c) Absence of secondary growth
d) Presence of flowers

Answer: b) Production of ovules on leaf-like structures

277. Bennettitales were most abundant during which geological period?
a) Carboniferous
b) Jurassic
c) Silurian
d) Devonian

Answer: b) Jurassic

278. The reproductive structures of Bennettitales resemble:
a) Gymnosperms
b) Angiosperms
c) Pteridophytes
d) Bryophytes

Answer: b) Angiosperms

279. The Cordaitales were dominant in which geological period?
a) Permian
b) Cambrian
c) Jurassic
d) Triassic

Answer: a) Permian

280. The leaves of Cordaitales were:
a) Small and needle-like
b) Large and strap-shaped
c) Compound
d) None of the above

Answer: b) Large and strap-shaped

281. The wood of Cycadofilicales shows characteristics of:
a) Gymnosperms
b) Angiosperms
c) Pteridophytes
d) Algae

Answer: a) Gymnosperms

282. The main difference between Cycadofilicales and true ferns is:
a) Seed-bearing nature of Cycadofilicales
b) Leaf venation pattern
c) Presence of vascular tissue
d) None of the above

Answer: a) Seed-bearing nature of Cycadofilicales

283. Which order of extinct plants is considered a link between ferns and gymnosperms?
a) Cordaitales
b) Bennettitales
c) Cycadofilicales
d) Ginkgoales

Answer: c) Cycadofilicales

284. The fossil evidence of Bennettitales suggests their pollination was likely by:
a) Wind
b) Water
c) Insects
d) Self-pollination

Answer: c) Insects

285. Which era is known as the "Age of Reptiles"?
a) Paleozoic
b) Mesozoic
c) Cenozoic
d) Precambrian

Answer: b) Mesozoic

286. The most recent era in the geological time scale is:
a) Mesozoic
b) Paleozoic

c) Cenozoic
d) Cambrian

Answer: c) Cenozoic

287. The first life forms appeared in which era?
a) Mesozoic
b) Cenozoic
c) Precambrian
d) Paleozoic

Answer: c) Precambrian

288. Dinosaurs became extinct at the end of which period?
a) Triassic
b) Jurassic
c) Cretaceous
d) Permian

Answer: c) Cretaceous

289. The process of fossilization is also called:
a) Petrification
b) Percolation
c) Sedimentation
d) Fossil making

Answer: a) Petrification

290. Fossils that retain the actual body parts of an organism are called:
a) Impression fossils
b) True form fossils
c) Trace fossils
d) Mold fossils

Answer: b) True form fossils

291. Which type of fossil is formed by the replacement of organic material by minerals?
a) Mold fossil
b) Cast fossil
c) Petrified fossil
d) Carbonized fossil

Answer: c) Petrified fossil

292. Fossil footprints and burrows are examples of:
a) True form fossils
b) Trace fossils
c) Cast fossils
d) Resin fossils

Answer: b) Trace fossils

293. Fossilization mostly occurs in which type of rock?
a) Igneous
b) Sedimentary
c) Metamorphic
d) Volcanic

Answer: b) Sedimentary

294. Prof. Birbal Sahni was a pioneer in:
a) Paleobotany
b) Microbiology
c) Zoology
d) Mycology

Answer: a) Paleobotany

295. The Birbal Sahni Institute of Palaeosciences is located in:
a) New Delhi
b) Lucknow
c) Mumbai
d) Kolkata

Answer: b) Lucknow

296. Prof. Birbal Sahni was instrumental in studying fossils from:
a) Gondwana sediments
b) Deccan Traps
c) Himalayan region
d) Indo-Gangetic plains

Answer: a) Gondwana sediments

297. Prof. Birbal Sahni was awarded the:
a) Padma Bhushan
b) Bharat Ratna
c) Nobel Prize

d) Kalinga Prize

Answer: a) Padma Bhushan

298. The study of pollen grains in fossils is known as:
a) Dendrochronology
b) Palynology
c) Stratigraphy
d) Lithology

Answer: b) Palynology

299. Which method is used to determine the absolute age of fossils?
a) Carbon dating
b) Relative dating
c) Biostratigraphy
d) Lichenometry

Answer: a) Carbon dating

300. The technique used to study tree rings for age determination is:
a) Radiometric dating
b) Dendrochronology
c) Stratigraphy
d) Paleoecology

Answer: b) Dendrochronology

301. Which gas is released during radiocarbon dating?
a) Carbon dioxide
b) Oxygen
c) Nitrogen
d) Hydrogen

Answer: a) Carbon dioxide

302. Which type of dating method uses isotopes to determine fossil age?
a) Relative dating
b) Radiometric dating
c) Biostratigraphy
d) Dendrochronology

Answer: b) Radiometric dating

303. Which of the following features is characteristic of Bennettitales?
a) Unisexual cones

b) Bisexual reproductive structures resembling flowers
c) Absence of vascular tissue
d) Presence of spore-bearing leaves

Answer: b) Bisexual reproductive structures resembling flowers

304. Cordaitales are considered to be the ancestors of which modern group of plants?
a) Cycads
b) Conifers
c) Angiosperms
d) Pteridophytes

Answer: b) Conifers

305. The fossil genus Medullosa belongs to which extinct plant group?
a) Cordaitales
b) Bennettitales
c) Cycadofilicales
d) Ginkgoales

Answer: c) Cycadofilicales

306. The reproductive organs of Bennettitales were enclosed within:
a) Sporophylls
b) Bracts
c) A flower-like structure
d) Strobili

Answer: c) A flower-like structure

307. Which of the following statements about Cycadofilicales is correct?
a) They had simple leaves like conifers
b) They produced seeds
c) They lacked secondary growth
d) They were dominant in the Mesozoic era

Answer: b) They produced seeds

308. The first vascular plants appeared in which geological period?
a) Silurian
b) Cambrian
c) Jurassic
d) Permian

Answer: a) Silurian

309. The largest mass extinction event occurred at the end of which period?
a) Devonian
b) Triassic
c) Permian
d) Cretaceous

Answer: c) Permian

310. The Quaternary period is part of which era?
a) Mesozoic
b) Cenozoic
c) Paleozoic
d) Precambrian

Answer: b) Cenozoic

311. The dominance of gymnosperms was observed in which geological period?
a) Jurassic
b) Devonian
c) Carboniferous
d) Triassic

Answer: d) Triassic

312. Which of the following is NOT a period in the Mesozoic Era?
a) Triassic
b) Cretaceous
c) Jurassic
d) Ordovician

Answer: d) Ordovician

313. Which fossilization process preserves soft tissues by rapid mineral deposition?
a) Carbonization
b) Per-mineralization
c) Recrystallization
d) Compression

Answer: b) Per-mineralization

314. What type of fossil results from an organism being trapped in amber?
a) Mold fossil
b) Cast fossil
c) Resin fossil
d) Petrified fossil

Answer: c) Resin fossil

315. Carbonization is a fossilization process in which:
a) Organisms are replaced by silica
b) Organic material is compressed, leaving only a carbon outline
c) Shells dissolve, leaving cavities
d) Bones turn into rock

Answer: b) Organic material is compressed, leaving only a carbon outline

316. A mold fossil forms when:
a) Minerals replace organic tissues
b) An organism leaves an impression in sediment
c) An organism is preserved in tar
d) A plant fossilizes in volcanic ash

Answer: b) An organism leaves an impression in sediment

317. Fossilized animal burrows or footprints are classified as:
a) Body fossils
b) Trace fossils
c) Cast fossils
d) Mold fossils

Answer: b) Trace fossils

318. Which of the following is NOT a contribution of Prof. Birbal Sahni?
a) Study of Gondwana flora
b) Establishment of the Birbal Sahni Institute of Palaeosciences
c) Discovery of the Double Helix structure of DNA
d) Research on plant fossils in India

Answer: c) Discovery of the Double Helix structure of DNA

319. Prof. Birbal Sahni's work helped in understanding the evolution of:
a) Dinosaurs
b) Angiosperms
c) Fossil plants of India
d) Mammals

Answer: c) Fossil plants of India

320. Which dating technique measures the decay of uranium isotopes in fossils?
a) Radiocarbon dating

b) Dendrochronology
c) Uranium-lead dating
d) Potassium-argon dating

Answer: c) Uranium-lead dating

321. Which of the following is a non-destructive method for studying fossils?
a) Sectioning
b) Acid digestion
c) X-ray tomography
d) Crushing the fossil

Answer: c) X-ray tomography

UNIT-V: Angiosperm Morphology (Stem, Roots, Leaves & Flower, Inflorescence)

Root Morphology and Modifications: -

- Morphology of Root
  - The root is typically the underground, non-green, positively geotropic, and hydrotropic part of the plant axis.
  - It develops from the radicle of the embryo.
  - No nodes and internodes.
  - Root hairs present for absorption.
  - Bears root caps at tips (except in aquatic plants like Pistia where root pockets are present).

- Types of Root Systems
  - Tap Root System – Develops directly from the radicle; consists of a main root and lateral branches. Seen in dicots (e.g., Hibiscus, Mustard).
  - Fibrous Root System – Group of roots arise from the base of the stem, replacing the tap root. Seen in monocots (e.g., Wheat, Maize).
  - Adventitious Roots – Develop from any part of the plant other than radicle. E.g., roots arising from stem cuttings (e.g., Money Plant), or from leaves (Bryophyllum).

- Modifications of Roots

Type	Modification	Example	Function
Storage	Fusiform	Radish (Raphanus)	Storage of food
	Napiform	Turnip (Brassica)	Storage of food
	Tuberous	Sweet Potato (Ipomoea)	Storage of food
Mechanical Support	Prop roots	Banyan (Ficus benghalensis)	Support to heavy branches
	Stilt roots	Maize, Sugarcane	Support for weak stems
Respiratory	Pneumatophores	Mangroves (Rhizophora)	Respiration in water-logged soils
Reproductive	Root tubers	Sweet potato	Vegetative propagation
Photosynthetic	Assimilatory roots	Trapa, Tinospora	Photosynthesis
Parasitic	Haustorial roots	Cuscuta	Absorb food from host plant

Stem Morphology and Modifications: -

- Morphology of Stem
  - The stem is the aerial, ascending part of the plant, which develops from the plumule of the embryo.
  - Bears nodes, internodes, leaves, buds, and branches.
  - Positively phototropic and negatively geotropic.
  - May be herbaceous or woody.

- Functions of Stem
  - Support to leaves and flowers.
  - Conduction of water and minerals (xylem) and food (phloem).
  - Storage and vegetative propagation.
  - Sometimes modified for protection or photosynthesis.

- Modifications of Stem
  - *Underground Modifications (For storage and perennation)*

Type	Example	Characteristic
Rhizome	Ginger, Turmeric	Horizontal, has nodes and internodes
Tuber	Potato	Swollen tips of underground branches
Bulb	Onion, Garlic	Fleshy leaf bases store food
Corm	Colocasia	Solid, vertical with buds on top

  - *Sub-aerial Modifications (For vegetative propagation)*

Type	Example	Function
Runner	Grass	Propagation
Stolon	Mint	Propagation
Offset	Pistia, Eichhornia	Floating aquatic plant spread
Sucker	Chrysanthemum	New shoots from base

  - Aerial Modifications

Type	Example	Function
Tendrils	Grape vine, Pumpkin	Climbing
Thorns	Bougainvillea	Defense
Phylloclade	Opuntia, Euphorbia	Photosynthesis in desert
Cladode	Asparagus	One internode green stem

Leaf Morphology and Modifications: -

- Morphology of Leaf
  - Arises from the node; has three parts: Leaf base, petiole, and lamina (leaf blade).
  - Types of leaves: Simple – Single lamina. Compound – Lamina divided into leaflets (Pinnately or Palmately compound).
  - Venation: Reticulate – Net-like (e.g., Pea, Mango – dicots). Parallel – Veins run parallel (e.g., Grass, Banana – monocots).

- Modifications of Leaves

Type	Example	Function
Leaf Tendrils	Pea	Climbing
Spines	Cactus	Protection
Phyllode	Australian Acacia	Photosynthesis
Insectivorous Leaves	Nepenthes, Drosera	Trapping insects
Reproductive Leaves	Bryophyllum	Vegetative propagation
Scale Leaves (leaf bases)	Onion	Storage

Bud Morphology: -

- Bud – An undeveloped or embryonic shoot.
- Types of Buds: Terminal Bud: At apex of stem. Axillary Bud: In axil of leaf. Adventitious Bud: On roots, internodes (e.g., Bryophyllum, Dahlia).
- Functions: Give rise to branches, flowers, or vegetative structures. Important in vegetative propagation.

Inflorescence and Its Types: -

Inflorescence is the mode of arrangement of flowers on the floral axis or peduncle.

- Types of Inflorescences

Type	Sub-type	Example	Characteristics
Racemose	Raceme	Radish	Older flowers at base, youngest at top
	Spike	Achyranthes	Sessile flowers on elongated axis
	Umbel	Onion	Pedicels arise from same point
	Corymb	Cauliflower	Lower pedicels longer
	Capitulum/Head	Sunflower	Sessile flowers on a flat receptacle
Cymose	Monochasial	Jasmine	Single lateral branch from each axis
	Dichasial	Bougainvillea	Two branches from each axis

	Polychasial	Hamelia	Many branches from same point
Special	Cyathium	Euphorbia	One female + male flowers in cup-shaped involucre
	Hypanthodium	Ficus	Flask-shaped with opening
	Verticillaster	Tulsi	False whorl at node

Flower Structure and Parts: -

- A flower is a modified shoot specialized for sexual reproduction.
- Parts of Flower: Calyx (Sepals) – Protects bud. Corolla (Petals) – Attracts pollinators. Androecium (Stamens) – Male reproductive part: anther + filament. Gynoecium (Carpels/Pistil) – Female part: stigma, style, ovary.

- Floral Types:
  - Complete – All 4 whorls present.
  - Incomplete – One or more whorls absent.
  - Actinomorphic – Radial symmetry (e.g., Mustard).
  - Zygomorphic – Bilateral symmetry (e.g., Pea).
  - Hypogynous – Superior ovary (e.g., Mustard).
  - Perigynous – Half superior and half inferior Ovary (e.g., Rose).
  - Epigynous – Inferior ovary (e.g., Guava).

- Fruits and Placentation
  - Develops from ovary after fertilization.
  - Simple – From a single ovary (e.g., Mango).
  - Aggregate – From multiple ovaries of a single flower (e.g., Strawberry).
  - Multiple – From inflorescence (e.g., Pineapple).

- Types of Fruits:
  - Fleshy – Drupe (Mango), Berry (Tomato).
  - Dry – Dehiscent (Pea), Indehiscent (Wheat).
  - Schizocarpic-a dry fruit that splits into two or more parts (mericarps) at maturity, with each part containing a single seed (coriander, and cumin).
  - Parthenocarpic – Without fertilization (Banana).

- Placentation Types:

Type	Example	Feature

Marginal	Pea	Placenta along margin of ovary
Axile	Tomato, Lemon	Placenta at center with septa
Parietal	Mustard	Placenta on ovary wall
Free central	Dianthus	Ovules on central column
Basal	Sunflower	Single ovule at base
Superficial	Water Lily	Ovules on entire inner wall

Seeds: Definition and Types: -

- Seed – Matured ovule containing embryo and stored food, enclosed in a seed coat.
- Parts: Seed coat (Testa and Tegmen). Embryo (Radicle, Plumule, Cotyledon). Endosperm (in some).

- Types of Seeds:

Type	Example	Feature
Monocot	Maize, Rice	One cotyledon, endospermic
Dicot	Pea, Gram	Two cotyledons, mostly non-endospermic
Endospermic	Castor, Maize	Food in endosperm
Non-endospermic	Pea, Bean	Food in cotyledons
Albuminous	Wheat, Barley	Endosperm retained
Exalbuminous	Gram, Groundnut	Endosperm absorbed during development

322. Which of the following is a modification of the taproot system?
a) Prop root
b) Pneumatophore
c) Tuberous root
d) Stolon

Answer: c) Tuberous root

323. Which type of root is found in maize and sugarcane that provides additional support?
a) Adventitious root
b) Prop root
c) Stilt root
d) Buttress root

Answer: c) Stilt root

324. Which modification of the root is found in Rhizophora for respiration?
a) Pneumatophores
b) Nodulated root
c) Epiphytic root
d) Tuberous root

Answer: a) Pneumatophores

325. Ginger is an example of which type of stem modification?
a) Corm
b) Rhizome
c) Tuber
d) Bulb

Answer: b) Rhizome

326. A stem that grows underground and stores food is called:
a) Stolon
b) Rhizome
c) Bulb
d) Runner

Answer: b) Rhizome

327. Which of the following is an example of a phylloclade?
a) Opuntia
b) Mint
c) Grass
d) Asparagus

Answer: a) Opuntia

328. Which type of leaf modification helps in climbing?
a) Phyllode
b) Tendrils
c) Spines
d) Pitcher

Answer: b) Tendrils

329. What is the main function of spines in xerophytic plants?
a) Photosynthesis
b) Water storage
c) Protection
d) Respiration

Answer: c) Protection

330. Which of the following is an example of a bud modification?
a) Thorn
b) Rhizome
c) Bulbil
d) Tuber

Answer: c) Bulbil

331. In which plant do leaf tendrils help in climbing?
a) Cucurbita
b) Pea
c) Mango
d) Opuntia

Answer: b) Pea

332. Which of the following is a racemose inflorescence?
a) Cyathium
b) Capitulum
c) Cymose
d) Verticillaster

Answer: b) Capitulum

333. In which type of inflorescence do flowers develop in a basipetal succession?
a) Racemose
b) Cymose

c) Capitulum
d) Spadix

Answer: b) Cymose

334. Which inflorescence is characteristic of the sunflower?
a) Cyathium
b) Verticillaster
c) Capitulum
d) Corymb

Answer: c) Capitulum

335. A flower with both male and female reproductive organs is called:
a) Unisexual
b) Bisexual
c) Staminate
d) Pistillate

Answer: b) Bisexual

336. Which of the following is a monochlamydeous flower?
a) Hibiscus
b) Sunflower
c) Amaranthus
d) Rose

Answer: c) Amaranthus

337. The floral whorl that encloses and protects the inner whorls is called:
a) Corolla
b) Androecium
c) Calyx
d) Gynoecium

Answer: c) Calyx

338. What type of placentation is found in tomato?
a) Axile
b) Basal
c) Parietal
d) Free central

Answer: a) Axile

339. In which type of placentation do ovules develop on the periphery of the ovary?

a) Axile
b) Basal
c) Marginal
d) Parietal

Answer: d) Parietal

340. What is the function of petals in a flower?
a) Photosynthesis
b) Protection
c) Attracting pollinators
d) Water absorption

Answer: c) Attracting pollinators

341. Gynoecium consists of:
a) Sepals
b) Stamens
c) Carpels
d) Petals

Answer: c) Carpels

342. Which of the following is a drupe fruit?
a) Mango
b) Tomato
c) Wheat
d) Apple

Answer: a) Mango

343. Which of the following is a dry dehiscent fruit?
a) Coconut
b) Pea
c) Mango
d) Apple

Answer: b) Pea

344. A pome fruit develops from which part of the flower?
a) Ovary
b) Thalamus
c) Sepals
d) Petals

Answer: b) Thalamus

345. An example of a legume fruit is:
a) Wheat
b) Gram
c) Tomato
d) Mango

Answer: b) Gram

346. The pericarp of a drupe fruit consists of how many layers?
a) One
b) Two
c) Three
d) Four

Answer: c) Three

347. A dicot seed has:
a) One cotyledon
b) Two cotyledons
c) No cotyledon
d) Many cotyledons

Answer: b) Two cotyledons

348. In which type of seed is endosperm absent?
a) Monocot
b) Dicot
c) Albuminous
d) Non-albuminous

Answer: d) Non-albuminous

349. A monocot seed differs from a dicot seed in having:
a) Two cotyledons
b) One cotyledon
c) Three cotyledons
d) No cotyledon

Answer: b) One cotyledon

350. The seed coat develops from:
a) Ovary
b) Ovule
c) Endosperm
d) Placenta

Answer: b) Ovule

351. The micropyle in a seed helps in:
a) Transpiration
b) Water absorption
c) Photosynthesis
d) Pollination

Answer: b) Water absorption

352. Which type of stem modification helps in vegetative propagation?
a) Tuber
b) Runner
c) Rhizome
d) All of the above

Answer: d) All of the above

353. Which plant shows the presence of a bulb as a stem modification?
a) Potato
b) Onion
c) Ginger
d) Carrot

Answer: b) Onion

354. Which of the following is a modification of a stem that stores food?
a) Stolon
b) Tuber
c) Runner
d) Offset

Answer: b) Tuber

355. Which type of leaf modification is found in Australian Acacia?
a) Phyllode
b) Leaf tendril
c) Leaf spine
d) Leaf pitcher

Answer: a) Phyllode

356. Which of the following is NOT an underground modification of the stem?
a) Rhizome
b) Tuber

c) Corm
d) Nodulated root

Answer: d) Nodulated root

357. A hypogynous flower has:
a) Ovary above other floral parts
b) Ovary below other floral parts
c) Ovary enclosed within the receptacle
d) Ovary absent

Answer: a) Ovary above other floral parts

358. Which of the following inflorescence types is characteristic of the family Fabaceae?
a) Capitulum
b) Cyathium
c) Raceme
d) Spadix

Answer: c) Raceme

359. In which type of flower are sepals and petals indistinguishable?
a) Unisexual
b) Monochlamydeous
c) Bisexual
d) Actinomorphic

Answer: b) Monochlamydeous

360. Which inflorescence type is found in Ficus (banyan)?
a) Umbel
b) Syconus
c) Catkin
d) Corymb

Answer: b) Syconus

361. A flower that lacks one or more whorls is called:
a) Complete
b) Incomplete
c) Perfect
d) Bisexual

Answer: b) Incomplete

362. The placentation in mustard is:
a) Marginal
b) Axile
c) Free central
d) Parietal

Answer: d) Parietal

363. Which part of the flower develops into a fruit?
a) Ovule
b) Ovary
c) Style
d) Stigma

Answer: b) Ovary

364. The ovule is attached to the ovary wall through:
a) Funiculus
b) Integument
c) Chalaza
d) Nucellus

Answer: a) Funiculus

365. In which of the following is basal placentation found?
a) Tomato
b) Pea
c) Marigold
d) Mustard

Answer: c) Marigold

366. Which of the following plants has free central placentation?
a) Dianthus
b) Sunflower
c) Pea
d) Mango

Answer: a) Dianthus

367. An example of a schizocarpic fruit is:
a) Castor
b) Cotton
c) Pea
d) Coconut

Answer: a) Castor

368. Which of the following fruits is a caryopsis?
a) Wheat
b) Tomato
c) Mango
d) Apple

Answer: a) Wheat

369. Which of the following is an example of an aggregate fruit?
a) Strawberry
b) Mango
c) Apple
d) Coconut

Answer: a) Strawberry

370. Which type of seed dispersal mechanism is present in cotton?
a) Wind
b) Water
c) Animals
d) Explosion

Answer: a) Wind

371. In monocot seeds, the protective covering of the plumule is called:
a) Scutellum
b) Coleorhiza
c) Coleoptile
d) Tegmen

Answer: c) Coleoptile

372. The microsporangium is commonly known as:
a) Ovule
b) Anther
c) Pollen grain
d) Stigma

Answer: b) Anther

373. The innermost layer of the microsporangium that nourishes developing pollen grains is:
a) Epidermis
b) Tapetum

c) Middle layers
d) Endothecium

Answer: b) Tapetum

374. Microsporogenesis refers to:
a) Formation of pollen grains
b) Formation of ovules
c) Formation of endosperm
d) Fertilization process

Answer: a) Formation of pollen grains

375. The microspore mother cell undergoes:
a) Mitosis
b) Meiosis
c) Amitosis
d) None of the above

Answer: b) Meiosis

376. The mature pollen grain represents:
a) Male gametophyte
b) Female gametophyte
c) Zygote
d) Endosperm

Answer: a) Male gametophyte

377. The megasporangium is also called:
a) Anther
b) Ovule
c) Pollen sac
d) Stigma

Answer: b) Ovule

378. The protective layers around the megasporangium are called:
a) Integuments
b) Nucellus
c) Endosperm
d) Funiculus

Answer: a) Integuments

379. The functional megaspore in angiosperms is generally:

a) The first formed megaspore
b) The middle one
c) The chalazal-most megaspore
d) Any of the four megaspores

Answer: c) The chalazal-most megaspore

380. Megasporogenesis involves:
a) Mitosis
b) Meiosis
c) Amitosis
d) Binary fission

Answer: b) Meiosis

381. The female gametophyte develops from:
a) Embryo sac
b) Megaspore
c) Pollen grain
d) Antheridium

Answer: b) Megaspore

382. The most common type of embryo sac in angiosperms is:
a) Monosporic
b) Bisporic
c) Tetrasporic
d) Polyembryonic

Answer: a) Monosporic

383. The female gametophyte consists of:
a) Egg apparatus
b) Antipodal cells
c) Central cell
d) All of the above

Answer: d) All of the above

384. The number of nuclei in a mature embryo sac is:
a) 4
b) 6
c) 7
d) 8

Answer: d) 8

385. In Polygonum type embryo sac, the synergids are located:
a) Near the chalazal end
b) Near the micropylar end
c) In the middle
d) Randomly distributed

Answer: b) Near the micropylar end

386. Pollination refers to:
a) Transfer of pollen grains to the ovule
b) Transfer of pollen grains to stigma
c) Fusion of male and female gametes
d) Development of fruit

Answer: b) Transfer of pollen grains to stigma

387. Self-pollination is also known as:
a) Autogamy
b) Geitonogamy
c) Xenogamy
d) Anemophily

Answer: a) Autogamy

388. Pollination by wind is termed:
a) Hydrophily
b) Anemophily
c) Entomophily
d) Ornithophily

Answer: b) Anemophily

389. Cross-pollination occurs between:
a) Two different flowers of the same plant
b) Two flowers of different plants
c) Within the same flower
d) Within the same ovule

Answer: b) Two flowers of different plants

390. Double fertilization is unique to:
a) Gymnosperms
b) Angiosperms
c) Algae
d) Bryophytes

Answer: b) Angiosperms

391. The fusion of one male gamete with the egg forms:
a) Endosperm
b) Zygote
c) Embryo sac
d) Nucellus

Answer: b) Zygote

392. The product of triple fusion is:
a) Embryo
b) Endosperm
c) Ovule
d) Synergid

Answer: b) Endosperm

393. Dicot embryos possess:
a) One cotyledon
b) Two cotyledons
c) No cotyledons
d) Multiple cotyledons

Answer: b) Two cotyledons

394. The main function of the endosperm is:
a) Seed dispersal
b) Providing nutrition to the developing embryo
c) Protection of the seed
d) Absorption of water

Answer: b) Providing nutrition to the developing embryo

395. Polyembryony refers to:
a) Development of multiple embryos in a single seed
b) Absence of embryo
c) Formation of embryo without fertilization
d) Formation of endosperm

Answer: a) Development of multiple embryos in a single seed

396. Apomixis is:
a) Formation of seeds without fertilization
b) Formation of endosperm without fertilization

c) Seed dormancy
d) None of the above

Answer: a) Formation of seeds without fertilization

397. Pollen grains germinate in the presence of:
a) Water
b) Sugar solution
c) Pollen tube enzymes
d) Stigma secretion

Answer: d) Stigma secretion

398. The first structure formed during pollen germination is:
a) Vegetative nucleus
b) Pollen tube
c) Generative cell
d) Tube nucleus

Answer: b) Pollen tube

399. The male gametophyte in angiosperms consists of:
a) One cell
b) Two or three cells
c) Four cells
d) Five cells

Answer: b) Two or three cells

400. In pollen grains, the generative cell divides to form:
a) Two sperm cells
b) Three sperm cells
c) Four sperm cells
d) Zygote

Answer: a) Two sperm cells

401. The exine of pollen grains is made up of:
a) Cutin
b) Sporopollenin
c) Cellulose
d) Pectin

Answer: b) Sporopollenin

402. The process of fusion of the male and female gametes is called:
a) Pollination
b) Syngamy
c) Parthenocarpy
d) Apomixis

Answer: b) Syngamy

403. The primary endosperm nucleus is formed by:
a) Fusion of one male gamete with the egg cell
b) Fusion of one male gamete with two polar nuclei
c) Fusion of two male gametes
d) None of the above

Answer: b) Fusion of one male gamete with two polar nuclei

404. The first cell of the embryo is the:
a) Endosperm
b) Zygote
c) Suspensor
d) Antipodal cell

Answer: b) Zygote

405. The suspensor in an embryo helps in:
a) Absorbing nutrients
b) Photosynthesis
c) Pollination
d) Seed dispersal

Answer: a) Absorbing nutrients

406. The process of endosperm development before embryo development is called:
a) Pre-fertilization
b) Precursor development
c) Precursor embryogenesis
d) Precedence of endosperm

Answer: d) Precedence of endosperm

407. The cotyledon in a monocot embryo is called:
a) Radicle
b) Plumule
c) Scutellum
d) Coleoptile

Answer: c) Scutellum

408. The part of the embryo that develops into the shoot is:
a) Radicle
b) Plumule
c) Hypocotyl
d) Endosperm

Answer: b) Plumule

409. The root cap in a monocot embryo is formed by:
a) Plumule
b) Radicle
c) Coleorhiza
d) Suspensor

Answer: c) Coleorhiza

410. The function of the endosperm in seeds is to:
a) Absorb nutrients from soil
b) Provide nutrients to the developing embryo
c) Protect the embryo from infection
d) Transport water

Answer: b) Provide nutrients to the developing embryo

411. In dicot seeds, the food is stored in:
a) Cotyledons
b) Radicle
c) Endosperm
d) Coleorhiza

Answer: a) Cotyledons

412. In coconut, the liquid endosperm is called:
a) Scutellum
b) Perisperm
c) Cytoplasmic endosperm
d) Free-nuclear endosperm

Answer: d) Free-nuclear endosperm

413. The main type of endosperm found in angiosperms is:
a) Cellular
b) Nuclear
c) Helobial

d) All of the above

Answer: d) All of the above

414. The perisperm in seeds is derived from:

a) Endosperm
b) Integuments
c) Nucellus
d) Cotyledons

Answer: c) Nucellus

415. The persistent endosperm in some mature seeds, such as maize and coconut, is called:

a) Albuminous
b) Exalbuminous
c) Pericarp
d) Endothecium

Answer: a) Albuminous

416. Polyembryony was first discovered by:

a) Antonie van Leeuwenhoek
b) Hans Molisch
c) F. T. Lewis
d) Leeuwenhoek

Answer: d) Leeuwenhoek

417. Adventive embryony is a type of polyembryony in which embryos arise from:

a) Synergids
b) Antipodal cells
c) Nucellar or integumentary cells
d) Egg cell

Answer: c) Nucellar or integumentary cells

418. Apomixis differs from sexual reproduction as it:

a) Does not involve fertilization
b) Requires pollination
c) Produces variable offspring
d) Depends on double fertilization

Answer: a) Does not involve fertilization

419. Citrus and mango show which type of polyembryony?

a) False polyembryony

b) Adventive polyembryony
c) True polyembryony
d) Vegetative polyembryony

Answer: b) Adventive polyembryony

420. The advantage of apomixis in plant breeding is:
a) Production of uniform progeny
b) High rate of mutations
c) Increased genetic variability
d) Formation of new species

Answer: a) Production of uniform progeny

421. Which of the following is an example of a plant that reproduces through apomixis?
a) Maize
b) Wheat
c) Dandelion
d) Pea

Answer: c) Dandelion

UNIT-VI: Plant Anatomy

Meristematic and Permanent Tissues: -

A. Meristematic Tissues

- Undifferentiated, actively dividing cells that contribute to primary and secondary growth of the plant.
- General Characteristics: Small, isodiametric cells. Dense cytoplasm, large nucleus. Thin primary cell walls. Lack intercellular spaces. Absence of vacuoles or small vacuoles. High metabolic activity.

- Types of Meristems:

i. Based on origin:

- Promeristem – present in the embryo; precursor to other meristems.
- Primary meristem – derived from promeristem; responsible for primary growth (length).
- Secondary meristem – arises from permanent tissues; responsible for secondary growth (girth), e.g., vascular cambium, cork cambium.

ii. Based on position:

- Apical Meristem: Located at tips of roots and shoots. Responsible for vertical growth.
- Intercalary Meristem: Located at base of nodes, internodes (e.g., in grasses). Responsible for regrowth of parts.
- Lateral Meristem: Located along the sides of stem and root. Responsible for increase in girth (e.g., vascular cambium, cork cambium).

B. Permanent Tissues

Cells that have lost the ability to divide and have become structurally and functionally specialized.

Types:

- Simple Permanent Tissues – composed of only one type of cell.

  - Parenchyma: Thin-walled, living cells. Function: storage, photosynthesis, secretion. May become meristematic under certain conditions.
  - Collenchyma: Living, elongated cells with irregularly thickened corners. Provides flexibility and mechanical strength. Found in young dicot stems, petioles.
  - Sclerenchyma: Dead cells with uniformly thick secondary walls (lignified). Provides mechanical support. Types: Fibers: elongated, thick-walled. Sclereids: variable shape, shorter.

- II. Complex Permanent Tissues – composed of different types of cells.
    - *Xylem:* Function: water and mineral conduction, mechanical support. Components: Tracheids, Vessels, Xylem fibers, Xylem parenchyma.
    - *Phloem:* Function: transport of organic solutes (photosynthates). Components: Sieve tube elements, Companion cells, Phloem fibers, Phloem parenchyma

Organs: Root, Stem, and Leaf: -

A. Root

- Epidermis: single-layered, with root hairs.
- Cortex: several layers of parenchyma.
- Endodermis: innermost layer of cortex, with Casparian strips.
- Pericycle: gives rise to lateral roots, vascular cambium, cork cambium.
- Vascular tissue: radial arrangement; xylem (exarch) and phloem alternate.

B. Stem

- Epidermis: outer protective layer with cuticle and stomata.
- Cortex: includes collenchyma (mechanical support), chlorenchyma (photosynthesis).
- Endodermis: starch sheath.
- Pericycle: beneath endodermis, gives rise to vascular cambium.
- Vascular bundles: xylem (endarch), collateral, open, arranged in a ring (dicot) and scattered (monocot).
- Pith: central parenchymatous region.

C. Leaf

- Upper epidermis: thick cuticle, stomata less frequent.
- Mesophyll: differentiated into palisade and spongy parenchyma.
- Vascular bundles: collateral, surrounded by bundle sheath.
- Lower epidermis: thinner cuticle, more stomata.

Apical Meristems & Theories of Apical Organization: -

A. Apical Meristem

- Located at the growing tips of root and shoot.
- Gives rise to all tissues through primary growth.
- Cells have high mitotic activity and undifferentiated nature.

B. Theories of Apical Organization

i. Apical Cell Theory:

- Proposed by: Hofmeister (1851).
- Observed in: Bryophytes, Pteridophytes.
- A single apical cell with a definite geometry governs all tissue development by successive divisions.

ii. Histogen Theory:

- Proposed by: Hanstein (1868).
- Suggests the apical meristem is composed of three distinct layers called histogens:
- Dermatogen: forms the epidermis.
- Periblem: forms the cortex.
- Plerome: forms the vascular tissue and pith.

iii. Tunica-Corpus Theory:

- Proposed by: Schmidt (1924).
- Divides shoot apex into two regions:
- Tunica: outermost layers, divide anticlinally (perpendicular to surface), form epidermis.
- Corpus: inner mass, divide in all planes (periclinal + anticlinal), form internal tissues like cortex and vascular bundles.

Secondary Growth in Root and Stem: -

A. Cambium – Structure and Function

- Structure: Cylindrical layer of meristematic tissue between xylem and phloem.
- Vascular Cambium Origin: From interfascicular and intrafascicular regions (in dicot stems). In roots, arises from pericycle and conjunctive tissue.
- Function: Produces secondary xylem on the inner side and secondary phloem on the outer side. Forms vascular rays for lateral conduction.

B. Annual Rings (Growth Rings)

- Due to variation in cambial activity during different seasons.
- Spring wood (early wood): larger vessels, formed during active growth.
- Autumn wood (late wood): denser, small vessels, formed during dormancy.
- One year = one ring → basis of dendrochronology (age determination).

Anomalous Secondary Growth: -

A. Bignonia

- Stem shows included or interxylary phloem.
- Cambium behaves abnormally; produces phloem on the inner side at certain places.

- Phloem strands get embedded in secondary xylem.
- Adaptive significance: flexible stem.

B. Boerhaavia

- Successive cambia arise from parenchyma in the pericycle.
- Forms concentric rings of vascular bundles separated by conjunctive tissue.
- Not derived from a single continuous cambial ring.
- Adaptation for storage and water conduction.

C. Dracaena (Monocot)

- Monocot stem showing secondary growth, which is rare.
- A secondary thickening meristem forms beneath the epidermis.
- Produces secondary vascular bundles and ground tissue.
- Bundles are amphivasal (xylem surrounded by phloem).
- Helps in mechanical support and water conduction.

D. Nyctanthes

- Root shows anomalous secondary growth.
- Cambium originates abnormally from pericycle and produces extra xylem and phloem.
- At some places, xylem appears outside phloem.
- Results in inverse orientation of vascular tissues.

422. Which of the following is a characteristic of meristematic tissues?
a) Cells have thick secondary walls
b) Cells are dead at maturity
c) Cells have large vacuoles
d) Cells are actively dividing

Answer: d) Cells are actively dividing

423. Which meristem is responsible for primary growth in plants?
a) Lateral meristem
b) Intercalary meristem
c) Apical meristem
d) Secondary meristem

Answer: c) Apical meristem

424. Lateral meristem is responsible for:
a) Increase in height
b) Increase in girth
c) Formation of flowers
d) Formation of leaves

Answer: b) Increase in girth

425. Which of the following meristems is found at the base of leaves and internodes?
a) Apical meristem
b) Lateral meristem
c) Intercalary meristem
d) Secondary meristem

Answer: c) Intercalary meristem

426. Cork cambium is an example of which type of meristem?
a) Apical meristem
b) Lateral meristem
c) Intercalary meristem
d) Permanent tissue

Answer: b) Lateral meristem

427. Which of the following is a primary meristem?
a) Cork cambium
b) Vascular cambium
c) Apical meristem
d) Secondary xylem

Answer: c) Apical meristem

428. Which meristem is responsible for wound healing in plants?
a) Apical meristem
b) Lateral meristem
c) Intercalary meristem
d) Secondary meristem

Answer: d) Secondary meristem

429. Vascular cambium produces:
a) Epidermis
b) Xylem and phloem
c) Pith
d) Cortex

Answer: b) Xylem and phloem

430. Which type of meristem is involved in the formation of secondary tissues?
a) Apical meristem
b) Intercalary meristem
c) Lateral meristem
d) Primary meristem

Answer: c) Lateral meristem

431. Which plant hormone promotes meristematic activity?
a) Abscisic acid
b) Auxin
c) Ethylene
d) Gibberellin

Answer: b) Auxin

432. Permanent tissues are derived from:
a) Primary xylem
b) Vascular cambium
c) Meristematic tissues
d) None of the above

Answer: c) Meristematic tissues

433. Which of the following is a simple permanent tissue?
a) Xylem
b) Phloem
c) Parenchyma
d) Epidermis

Answer: c) Parenchyma

434. Parenchyma cells are mostly:
a) Dead and lignified
b) Thin-walled and living
c) Thick-walled and dead
d) Found in xylem only

Answer: b) Thin-walled and living

435. Which of the following tissues stores food in plants?
a) Xylem
b) Phloem
c) Parenchyma
d) Sclerenchyma

Answer: c) Parenchyma

436. Which simple permanent tissue provides mechanical support to plants?
a) Parenchyma
b) Collenchyma
c) Phloem
d) Xylem

Answer: b) Collenchyma

437. Which of the following tissues has thickened corners?
a) Parenchyma
b) Collenchyma
c) Sclerenchyma
d) Xylem

Answer: b) Collenchyma

438. Sclerenchyma cells are:
a) Living and flexible
b) Dead and thick-walled
c) Thin-walled and living
d) Soft and delicate

Answer: b) Dead and thick-walled

439. Which of the following is a complex permanent tissue?
a) Parenchyma
b) Collenchyma
c) Sclerenchyma
d) Xylem

Answer: d) Xylem

440. Xylem transports:
a) Water only
b) Food only
c) Hormones only
d) None of the above

Answer: a) Water only

441. Phloem is responsible for the transport of:
a) Water
b) Nutrients
c) Organic food materials
d) None of the above

Answer: c) Organic food materials

442. Which of the following is NOT a component of xylem?
a) Tracheids
b) Vessels
c) Sieve tubes
d) Xylem parenchyma

Answer: c) Sieve tubes

443. Which part of phloem is responsible for the transport of food?
a) Companion cells
b) Sieve tubes
c) Phloem fibers
d) Phloem parenchyma

Answer: b) Sieve tubes

444. Which tissue provides maximum mechanical support to plants?
a) Parenchyma
b) Collenchyma
c) Sclerenchyma
d) Xylem

Answer: c) Sclerenchyma

445. The dead component of phloem is:
a) Sieve tube
b) Phloem fiber
c) Companion cell
d) Phloem parenchyma

Answer: b) Phloem fiber

446. Which phloem element controls the function of sieve tube elements?
a) Companion cells
b) Phloem fibers
c) Xylem parenchyma
d) Tracheids

Answer: a) Companion cells

447. Which type of meristematic tissue is responsible for the secondary growth of plants?

a) Apical meristem
b) Intercalary meristem
c) Lateral meristem
d) None of the above

Answer: c) Lateral meristem

448. Which of the following meristems gives rise to the vascular tissues?

a) Apical meristem
b) Cork cambium
c) Vascular cambium
d) Epidermal tissue

Answer: c) Vascular cambium

449. Intercalary meristem is found in:

a) Root tips
b) Leaf tips
c) Internodes of grasses
d) Vascular bundles

Answer: c) Internodes of grasses

450. Cells of meristematic tissues lack:

a) Plastids
b) Nucleus
c) Vacuoles
d) Cytoplasm

Answer: c) Vacuoles

451. Which type of meristem is responsible for the thickening of stems and roots?

a) Apical meristem
b) Lateral meristem
c) Intercalary meristem
d) None of the above

Answer: b) Lateral meristem

452. Which simple permanent tissue helps in photosynthesis in leaves?
a) Collenchyma
b) Sclerenchyma
c) Chlorenchyma
d) Xylem

Answer: c) Chlorenchyma

453. Collenchyma cells are commonly found in:
a) Petioles and young stems
b) Roots
c) Xylem
d) Phloem

Answer: a) Petioles and young stems

454. Which simple permanent tissue helps in gaseous exchange in aquatic plants?
a) Aerenchyma
b) Xylem
c) Phloem
d) Sclerenchyma

Answer: a) Aerenchyma

455. Which type of parenchyma stores starch?
a) Chlorenchyma
b) Aerenchyma
c) Storage parenchyma
d) Epidermis

Answer: c) Storage parenchyma

456. Which of the following simple tissues has uniformly thickened walls?
a) Parenchyma
b) Collenchyma
c) Sclerenchyma
d) Phloem

Answer: c) Sclerenchyma

457. Which permanent tissue consists of dead cells?
a) Xylem vessels
b) Phloem
c) Parenchyma
d) Collenchyma

Answer: a) Xylem vessels

458. Xylem fibers provide:
a) Conduction of food
b) Storage of water
c) Mechanical support
d) None of the above

Answer: c) Mechanical support

459. Which of the following is NOT a component of phloem?
a) Sieve tube elements
b) Companion cells
c) Xylem fibers
d) Phloem parenchyma

Answer: c) Xylem fibers

460. Which component of xylem helps in water conduction?
a) Xylem fibers
b) Tracheids and vessels
c) Phloem parenchyma
d) Sieve tubes

Answer: b) Tracheids and vessels

461. Which component of phloem provides strength?
a) Sieve tubes
b) Companion cells
c) Phloem fibers
d) Phloem parenchyma

Answer: c) Phloem fibers

462. Which xylem component is absent in gymnosperms?

a) Tracheids
b) Vessels
c) Xylem parenchyma
d) Xylem fibers

Answer: b) Vessels

463. Which cells in phloem help in the functioning of sieve tube elements?
a) Phloem fibers
b) Sclerenchyma
c) Companion cells
d) Phloem parenchyma

Answer: c) Companion cells

464. What is the main function of sieve tubes?
a) Transport of water
b) Transport of food
c) Provide mechanical support
d) Storage of starch

Answer: b) Transport of food

465. Which part of the xylem stores food?
a) Xylem fibers
b) Tracheids
c) Xylem vessels
d) Xylem parenchyma

Answer: d) Xylem parenchyma

466. Which part of the plant mainly consists of permanent tissues?
a) Root tip
b) Shoot apex
c) Mature stem
d) Root cap

Answer: c) Mature stem

467. Which meristematic tissue is responsible for the formation of branches?
a) Lateral meristem

b) Apical meristem
c) Intercalary meristem
d) None of the above

Answer: b) Apical meristem

468. Which simple tissue helps in wound healing?
a) Xylem
b) Parenchyma
c) Sclerenchyma
d) Phloem

Answer: b) Parenchyma

469. Which plant tissue forms the outer protective layer?
a) Xylem
b) Phloem
c) Epidermis
d) Parenchyma

Answer: c) Epidermis

470. Which of the following tissues has both living and dead components?
a) Xylem
b) Phloem
c) Parenchyma
d) Collenchyma

Answer: a) Xylem

471. Which of the following is a function of collenchyma?
a) Transport of food
b) Transport of water
c) Mechanical support
d) Photosynthesis

Answer: c) Mechanical support

472. The primary function of the root is:
a) Photosynthesis
b) Absorption of water and minerals

c) Transport of food
d) Reproduction

Answer: b) Absorption of water and minerals

473. Taproot system is characteristic of:
a) Monocots
b) Dicots
c) Pteridophytes
d) Bryophytes

Answer: b) Dicots

474. The region of the root responsible for the increase in length is:
a) Region of maturation
b) Region of elongation
c) Root cap
d) Region of meristematic activity

Answer: b) Region of elongation

475. Adventitious roots arise from:
a) Radicle
b) Plumule
c) Any part other than the radicle
d) None of these

Answer: c) Any part other than the radicle

476. Which type of root modification is found in sweet potato?
a) Conical
b) Napiform
c) Fusiform
d) Tuberous

Answer: d) Tuberous

477. Which of the following is NOT a function of the stem?
a) Support
b) Transport of nutrients
c) Photosynthesis
d) Absorption of water

Answer: d) Absorption of water

478. Rhizome is a type of:

a) Underground stem
b) Subaerial stem
c) Aerial stem
d) None of these

Answer: a) Underground stem

479. Which part of the leaf is responsible for photosynthesis?
a) Xylem
b) Phloem
c) Mesophyll
d) Epidermis

Answer: c) Mesophyll

480. The venation in monocot leaves is mostly:
a) Reticulate
b) Parallel
c) Dichotomous
d) None of these

Answer: b) Parallel

481. In dorsiventral leaves, the upper and lower surfaces are:
a) Identical
b) Different
c) Both green
d) None of these

Answer: b) Different

482. Pneumatophores are found in:
a) Mesophytes
b) Hydrophytes
c) Xerophytes
d) Mangroves

Answer: d) Mangroves

483. Which of the following is a stem modification?
a) Corm
b) Taproot
c) Fibrous root
d) None of these

Answer: a) Corm

484. The main function of guard cells in a leaf is:
a) Photosynthesis
b) Gaseous exchange
c) Transport of food
d) None of these

Answer: b) Gaseous exchange

485. Which of the following is an example of a compound leaf?
a) Mango
b) Guava
c) Rose
d) Sunflower

Answer: c) Rose

486. The primary function of the phloem is to transport:
a) Water
b) Minerals
c) Organic nutrients
d) None of these

Answer: c) Organic nutrients

487. Which part of the root perceives gravity?
a) Root hair
b) Root cap
c) Xylem
d) Phloem

Answer: b) Root cap

488. Which stem modification is used for vegetative propagation?
a) Stolon
b) Tuber
c) Rhizome
d) All of these

Answer: d) All of these

489. Which type of leaf arrangement has a single leaf at each node?
a) Opposite
b) Whorled
c) Alternate
d) Spiral

Answer: c) Alternate

490. In C4 plants, Kranz anatomy is found in:
a) Stems
b) Leaves
c) Roots
d) Flowers

Answer: b) Leaves

491. The xylem of a dicot root is:
a) Polyarch
b) Diarch to tetrarch
c) Monocot-like
d) None of these

Answer: b) Diarch to tetrarch

492. The apical meristem is responsible for:
a) Secondary growth
b) Primary growth
c) Root hair formation
d) None of these

Answer: b) Primary growth

493. The apical meristem is found at:
a) The tips of roots and stems
b) The base of the leaf
c) The middle of the stem
d) All of these

Answer: a) The tips of roots and stems

494. Which scientist proposed the Apical Cell Theory?
a) Nageli
b) Hanstein
c) Schmidt
d) Haberlandt

Answer: a) Nageli

495. According to Apical Cell Theory, growth in plants is controlled by:
a) A single apical cell
b) Multiple cells
c) Cambium

d) Xylem

Answer: a) A single apical cell

496. The Histogen Theory was proposed by:
a) Hanstein
b) Nageli
c) Schmidt
d) None of these

Answer: a) Hanstein

497. According to the Histogen Theory, the three primary meristematic layers are:
a) Dermal, ground, and vascular
b) Protoderm, procambium, and ground meristem
c) Dermatogen, periblem, and plerome
d) None of these

Answer: c) Dermatogen, periblem, and plerome

498. Dermatogen gives rise to:
a) Epidermis
b) Cortex
c) Vascular tissue
d) None of these

Answer: a) Epidermis

499. The Tunica-Corpus Theory was proposed by:
a) Hanstein
b) Nageli
c) Schmidt
d) Haberlandt

Answer: c) Schmidt

500. In Tunica-Corpus Theory, tunica is responsible for:
a) Volume increase
b) Surface growth
c) Lateral growth
d) None of these

Answer: b) Surface growth

501. The Corpus in Tunica-Corpus Theory gives rise to:
a) Epidermis

b) Inner tissues
c) Root cap
d) None of these

Answer: b) Inner tissues

502. Which of the following is a function of root hairs?
a) Support
b) Absorption of water and minerals
c) Photosynthesis
d) Transport of food

Answer: b) Absorption of water and minerals

503. Which of the following is an example of a prop root?
a) Sugarcane
b) Banyan
c) Maize
d) Mango

Answer: b) Banyan

504. In dicot stems, vascular bundles are:
a) Closed and scattered
b) Open and arranged in a ring
c) Closed and arranged in a ring
d) Scattered and open

Answer: b) Open and arranged in a ring

505. Which of the following is a characteristic feature of a monocot root?
a) Presence of cambium
b) Polyarch xylem
c) Secondary growth
d) Absence of pith

Answer: b) Polyarch xylem

506. A phylloclade is a modification of:
a) Leaf
b) Stem
c) Root
d) Flower

Answer: b) Stem

507. The movement of stomata is controlled by:
a) Xylem
b) Phloem
c) Guard cells
d) Cortex

Answer: c) Guard cells

508. A compound leaf differs from a simple leaf in having:
a) A single blade
b) Multiple leaflets
c) Opposite phyllotaxy
d) None of these

Answer: b) Multiple leaflets

509. Which of the following is a xerophytic adaptation in leaves?
a) Broad lamina
b) Thin cuticle
c) Sunken stomata
d) Increased number of stomata

Answer: c) Sunken stomata

510. Which of the following plants shows pinnately compound leaves?
a) Neem
b) Hibiscus
c) Mango
d) Banana

Answer: a) Neem

511. The presence of sclerenchyma in vascular bundles provides:
a) Photosynthesis
b) Strength and support
c) Absorption of nutrients
d) None of these

Answer: b) Strength and support

512. Which meristem is responsible for increasing the length of a plant?
a) Apical meristem
b) Lateral meristem
c) Intercalary meristem
d) None of these

Answer: a) Apical meristem

513. The tunica layer in Tunica-Corpus Theory is characterized by:
a) Anticlinal cell divisions
b) Periclinal cell divisions
c) Random cell divisions
d) No cell divisions

Answer: a) Anticlinal cell divisions

514. In Histogen Theory, which histogen gives rise to vascular tissue?
a) Dermatogen
b) Plerome
c) Periblem
d) None of these

Answer: b) Plerome

515. The apical cell theory is best applicable to:
a) Pteridophytes
b) Angiosperms
c) Gymnosperms
d) Bryophytes

Answer: d) Bryophytes

516. In which plant group is a single apical cell responsible for growth?
a) Pteridophytes
b) Bryophytes
c) Angiosperms
d) Gymnosperms

Answer: b) Bryophytes

517. Which of the following theories explains the zonation in shoot apex?
a) Apical Cell Theory
b) Histogen Theory
c) Tunica-Corpus Theory
d) None of these

Answer: c) Tunica-Corpus Theory

518. According to Histogen Theory, periblem forms:
a) Epidermis
b) Cortex
c) Vascular tissue
d) Root cap

Answer: b) Cortex

519. The corpus in the shoot apex is responsible for:
a) Surface growth
b) Volume growth
c) Root elongation
d) Leaf formation

Answer: b) Volume growth

520. Which of the following theories is NOT valid for angiosperms?
a) Apical Cell Theory
b) Histogen Theory
c) Tunica-Corpus Theory
d) None of these

Answer: a) Apical Cell Theory

521. The number of histogens in Histogen Theory is:
a) One
b) Two
c) Three
d) Four

Answer: c) Three

522. Secondary growth in plants is primarily due to the activity of which meristem?
a) Apical meristem
b) Intercalary meristem
c) Lateral meristem
d) Primary meristem

Answer: c) Lateral meristem

523. Which of the following plant groups typically show secondary growth?
a) Monocots
b) Dicots
c) Pteridophytes
d) Bryophytes

Answer: b) Dicots

524. The process of secondary growth results in an increase in:
a) Length of the plant
b) Width of the plant

c) Number of leaves
d) Number of roots

Answer: b) Width of the plant

525. Which tissue is mainly responsible for secondary growth in dicot stems?
a) Vascular cambium
b) Epidermis
c) Pith
d) Cortex

Answer: a) Vascular cambium

526. In which part of the plant does secondary growth occur?
a) Only in roots
b) Only in stems
c) Both roots and stems
d) Only in leaves

Answer: c) Both roots and stems

527. What is the primary role of secondary xylem in plants?
a) Photosynthesis
b) Transport of water
c) Storage of food
d) Gas exchange

Answer: b) Transport of water

528. Which of the following is a characteristic feature of secondary phloem?
a) Dead at maturity
b) Responsible for water transport
c) Conducts food throughout the plant
d) Found in monocots

Answer: c) Conducts food throughout the plant

529. Secondary growth is absent in which of the following plants?
a) Pinus
b) Mango
c) Bamboo
d) Quercus

Answer: c) Bamboo

530. The vascular cambium originates from which of the following?
a) Pith

b) Pericycle
c) Procambium
d) Endodermis

Answer: c) Procambium

531. The cambium responsible for producing secondary vascular tissues is called:
a) Cork cambium
b) Vascular cambium
c) Intercalary cambium
d) Primary meristem

Answer: b) Vascular cambium

532. What is the primary function of vascular cambium?
a) Production of new leaves
b) Formation of secondary xylem and phloem
c) Root elongation
d) Seed production

Answer: b) Formation of secondary xylem and phloem

533. Which of the following types of cells are produced by vascular cambium?
a) Xylem parenchyma
b) Phloem fibers
c) Tracheids and sieve tubes
d) All of the above

Answer: d) All of the above

534. The cork cambium is also known as:
a) Phellogen
b) Phellem
c) Phelloderm
d) Periderm

Answer: a) Phellogen

535. Which part of the plant produces cork cells?
a) Vascular cambium
b) Phelloderm
c) Phellogen
d) Endodermis

Answer: c) Phellogen

536. In which layer of the stem is the vascular cambium located?
a) Between xylem and phloem
b) Between cortex and epidermis
c) In the endodermis
d) Inside the pith

Answer: a) Between xylem and phloem

537. What is the function of ray initials in vascular cambium?
a) Forming vascular rays for lateral transport
b) Producing secondary phloem
c) Producing secondary xylem
d) Forming root hairs

Answer: a) Forming vascular rays for lateral transport

538. The growth rings in a tree trunk represent:
a) Secondary phloem layers
b) Seasonal activity of vascular cambium
c) Leaf scars
d) Primary xylem deposition

Answer: b) Seasonal activity of vascular cambium

539. What does a wide annual ring indicate?
a) Slow growth due to harsh climate
b) Fast growth due to favorable conditions
c) Lack of secondary growth
d) Damage by insects

Answer: b) Fast growth due to favorable conditions

540. Which part of the annual ring consists of large, thin-walled vessels?
a) Latewood
b) Heartwood
c) Earlywood
d) Sapwood

Answer: c) Earlywood

541. Which of the following can be used to estimate the age of a tree?
a) Number of leaves
b) Number of flowers
c) Number of annular rings
d) Size of the roots

Answer: c) Number of annular rings

542. What is the dark, non-functional wood at the center of a tree trunk called?
a) Sapwood
b) Heartwood
c) Pith
d) Cambium

Answer: b) Heartwood

543. Which type of xylem forms the majority of the annular rings?
a) Primary xylem
b) Secondary xylem
c) Protoxylem
d) Metaxylem

Answer: b) Secondary xylem

544. Growth rings are more prominent in trees growing in:
a) Tropical rainforest
b) Temperate regions
c) Deserts
d) Coastal areas

Answer: b) Temperate regions

545. What factors influence the thickness of growth rings?
a) Climate
b) Rainfall
c) Soil nutrients
d) All of the above

Answer: d) All of the above

546. Dendrochronology is the study of:
a) Fossils
b) Annual rings in trees
c) Root growth patterns
d) Leaf anatomy

Answer: b) Annual rings in trees

547. Anomalous secondary growth refers to:
a) Normal vascular cambium activity
b) Irregular or unusual vascular tissue development
c) Absence of secondary growth
d) Exclusive primary growth

Answer: b) Irregular or unusual vascular tissue development

548. Which of the following plants exhibit anomalous secondary growth?
a) Mangifera
b) Bignonia
c) Zea mays
d) All of the above

Answer: b) Bignonia

549. The main reason for anomalous secondary growth is:
a) Activity of normal cambium
b) Formation of successive cambia
c) Absence of vascular cambium
d) Suppression of primary growth

Answer: b) Formation of successive cambia

550. Anomalous secondary growth is most commonly seen in:
a) Dicot stems
b) Monocot roots
c) Gymnosperms
d) Algae

Answer: a) Dicot stems

551. Which of the following does not show anomalous secondary growth?
a) Dracaena
b) Nyctanthes
c) Boerhaavia
d) Helianthus

Answer: d) Helianthus

552. In Bignonia, anomalous secondary growth results due to:
a) Formation of accessory cambia
b) Development of interxylary phloem
c) Activity of normal cambium
d) Formation of concentric rings

Answer: b) Development of interxylary phloem

553. Interxylary phloem is found in:
a) Bignonia
b) Dracaena

c) Nyctanthes
d) Zea mays

Answer: a) Bignonia

554. The presence of interxylary phloem in Bignonia is an adaptation for:
a) Transport of water
b) Transport of food
c) Storage of starch
d) Structural support

Answer: b) Transport of food

555. In Bignonia, the interxylary phloem is formed due to:
a) Abnormal activity of the cambium
b) Successive cambia formation
c) Inclusion of primary phloem
d) Storage of secondary metabolites

Answer: a) Abnormal activity of the cambium

556. The function of interxylary phloem in Bignonia is primarily related to:
a) Secondary xylem transport
b) Food conduction
c) Mechanical support
d) Photosynthesis

Answer: b) Food conduction

557. Anomalous secondary growth in Boerhaavia is due to:
a) Formation of successive cambia
b) Irregular cambial activity
c) Inclusion of primary xylem
d) None of the above

Answer: a) Formation of successive cambia

558. Successive cambia in Boerhaavia originate from:
a) Procambium
b) Cortex
c) Pith
d) Pericycle

Answer: d) Pericycle

The vascular bundles in Boerhaavia are:
e) Radial

f) Collateral and amphivasal
g) Bicollateral
h) Concentric

Answer: c) Bicollateral

559. The vascular bundles in Boerhaavia are arranged in:
a) A single ring
b) Several rings due to successive cambium
c) No particular arrangement
d) Only in the center

Answer: b) Several rings due to successive cambium

560. The main characteristic of Boerhaavia's secondary growth is:
a) Presence of interxylary phloem
b) Presence of successive rings of vascular tissue
c) Formation of anomalous xylem
d) Growth from a normal cambium

Answer: b) Presence of successive rings of vascular tissue

561. Dracaena shows anomalous secondary growth due to:
a) Activity of secondary thickening meristem
b) Normal cambial activity
c) Presence of interxylary phloem
d) Ring formation in vascular tissues

Answer: a) Activity of secondary thickening meristem

562. The secondary thickening meristem in Dracaena is derived from:
a) Vascular cambium
b) Pericycle
c) Cortex
d) Hypodermis

Answer: c) Cortex

563. The secondary vascular tissues in Dracaena arise from:
a) Vascular cambium
b) Successive cambia
c) Secondary thickening meristem
d) None of the above

Answer: c) Secondary thickening meristem

564. The cells produced by the secondary thickening meristem in Dracaena include:
a) Phloem and xylem
b) Xylem and conjunctive tissue
c) Fibers only
d) Phloem only

Answer: b) Xylem and conjunctive tissue

565. What is the primary function of the conjunctive tissue in Dracaena?
a) Mechanical support
b) Food transport
c) Photosynthesis
d) Starch storage

Answer: a) Mechanical support

566. Anomalous secondary growth in Nyctanthes occurs due to:
a) Discontinuous cambium formation
b) Presence of successive cambia
c) Irregular vascular bundle formation
d) Interxylary phloem development

Answer: a) Discontinuous cambium formation

567. The cambium in Nyctanthes is:
a) Continuous
b) Discontinuous and present in patches
c) Absent
d) Present only in roots

Answer: b) Discontinuous and present in patches

568. What type of vascular bundles are present in Nyctanthes?
a) Amphivasal
b) Bicollateral
c) Concentric
d) Collateral and open

Answer: d) Collateral and open

569. Nyctanthes stem exhibits anomalous growth because of:
a) Normal cambial ring
b) Irregular cambial activity
c) Formation of successive cambia
d) Interxylary phloem

Answer: b) Irregular cambial activity

570. The secondary xylem in Nyctanthes is:
a) Uniform
b) Discontinuous
c) Amphivasal
d) Absent

Answer: b) Discontinuous

571. Which plant shows the most distinct interxylary phloem?
a) Nyctanthes
b) Boerhaavia
c) Bignonia
d) Dracaena

Answer: c) Bignonia

572. The presence of successive cambia is a characteristic of:
a) Bignonia
b) Boerhaavia
c) Dracaena
d) None of the above

Answer: b) Boerhaavia

573. In Dracaena, the secondary thickening meristem is found in:
a) Vascular cambium
b) Cortex
c) Pericycle
d) Xylem

Answer: b) Cortex

574. What is the function of secondary thickening meristem?
a) Increases girth
b) Forms new leaves
c) Helps in photosynthesis
d) Stores food

Answer: a) Increases girth

575. Which plant exhibits discontinuous cambial activity?
a) Dracaena
b) Nyctanthes
c) Boerhaavia
d) Bignonia

Answer: b) Nyctanthes

UNIT-VII: Reproductive Botany

Plant Embryology:

Plant embryology is a sub-discipline of botany dealing with the formation, development, and structure of reproductive cells, fertilization, and the development of the embryo, endosperm, seed, and fruit in angiosperms. It includes: development of microsporangia and megasporangia, gamete formation (microsporogenesis and megasporogenesis), fertilization, embryo and endosperm development, and apomixis and polyembryony.

Structure of Microsporangium: -

- The anther of a stamen is tetrasporangiate (has 4 microsporangia).
- Epidermis: outermost single layer, has protective function.
- Endothecium: lies below the epidermis. Develops fibrous thickenings (for anther dehiscence).
- Middle layers: 1 to 3 layers of parenchyma. Degenerate at maturity.
- Tapetum: innermost nutritive layer. May be secretory (glandular) or amoeboid. Provides nutrients and contributes to pollen wall formation.
- Central Region:
- Sporogenous tissue: Contains diploid microspore mother cells (MMCs).

Microsporogenesis: -

The process by which microspore mother cells (MMCs) undergo meiosis to form haploid microspores.

- MMCs (2n) undergo meiosis I and II.
- Forms microspore tetrads (4 haploid microspores).
- Tetrad types: Tetrahedral, Isobilateral, Linear, T-shaped.
- Each microspore develops into a pollen grain.

Structure of Megasporangium (Ovule):-

An ovule is a megasporangium surrounded by protective tissues.

Parts of Ovule:

- Funicle – stalk attaching ovule to placenta.
- Hilum – point of attachment of ovule to funicle.
- Integuments – protective layers (1 or 2) surrounding nucellus.
- Micropyle – opening left by integuments; entry point of pollen tube.
- Nucellus – central mass of parenchymatous tissue with MMC.
- Chalaza – basal part opposite to micropyle.

- Embryo sac – develops inside the nucellus.

Types of Ovules:

- Orthotropous – straight ovule, micropyle, nucellus, chalaza aligned.
- Anatropous – inverted ovule, micropyle near funicle (most common).
- Campylotropous – curved ovule (e.g., Leguminosae).
- Amphitropous, Hemianatropous, and Circinotropous – less common.

Megasporogenesis: -

Formation of megaspore from the megaspore mother cell (MMC) inside the nucellus of the ovule.

- MMC (2n) undergoes meiosis → 4 haploid megaspores.
- Usually, only one megaspore (chalazal) is functional.
- The functional megaspore undergoes mitotic divisions to form embryo sac (female gametophyte).

Structure and Types of Female Gametophyte (Embryo Sac): -

Polygonum Type (most common, monosporic):

- Formed from a single functional megaspore.
- 3 mitotic divisions → 8 nuclei, arranged in 7 cells:
- 3 Antipodals (chalazal end)
- 2 Synergids + 1 Egg cell (micropylar end)
- 1 Central Cell with 2 polar nuclei (central)

Types of Embryo Sac Development:

- Monosporic – from one megaspore (e.g., Polygonum type).
- Bisporic – from two meiotic nuclei (e.g., Allium).
- Tetrasporic – from all four nuclei (e.g., Peperomia).

Types of Pollination: -

- Autogamy – pollen transfer within the same flower. E.g., Pea, Wheat.
- Geitonogamy – transfer between different flowers of the same plant. Genetically similar to autogamy.
- Xenogamy – cross-pollination between flowers of different plants. Genetically diverse, leads to variation.

Methods of Pollination: -

Abiotic Pollination:

- Anemophily – Wind (e.g., grasses, maize)

- Hydrophily – Water (e.g., Vallisneria, Hydrilla)

Biotic Pollination:

- Entomophily – Insects (e.g., sunflower, rose)
- Ornithophily – Birds (e.g., Bombax, Bignonia)
- Chiropterophily – Bats (e.g., Kigelia)
- Malacophily – Mollusks (rare)

Germination of Pollen Grain: -

- Occurs on stigma of the flower.
- Pollen grain absorbs moisture, swells, and forms pollen tube.
- The tube grows through style, guided by synergids.
- Generative cell divides to form two male gametes.
- Pollen tube enters ovule via micropyle or chalaza.

Structure of Male Gametophyte (Pollen Grain): -

- Pollen Grain: Immature male gametophyte.
- Surrounded by: Exine (outer wall; sporopollenin – highly resistant). Intine (inner wall; cellulose + pectin).
- Two cells: Vegetative Cell – large, forms pollen tube. Generative Cell – divides to form two male gametes.

Fertilization: -

- Syngamy: Fusion of one male gamete with egg → zygote (2n).
- Triple Fusion: Fusion of second male gamete with two polar nuclei → primary endosperm nucleus (3n). Together called Double Fertilization (unique to angiosperms). Occurs in the embryo sac.

Structure of Dicot Embryo: -

Parts of dicot embryo (e.g., Capsella):

- Radicle – future root.
- Plumule – future shoot.
- Hypocotyl – stem-like region between radicle and cotyledons.
- Epicotyl – above cotyledons.
- Cotyledons – two large storage organs.

Structure of Monocot Embryo: -

Parts (e.g., maize):

- Scutellum – single cotyledon.
- Plumule – enclosed in coleoptile.
- Radicle – enclosed in coleorhiza.
- Epiblast – small projection near scutellum.

Endosperm: -

- Nutritive tissue supporting embryo development.
- Arises from the primary endosperm nucleus (3n).
- May persist (as in cereals) or be absorbed (e.g., in beans).

Types of Endosperms:

- Nuclear – free nuclear divisions (no cell walls at first), e.g., maize.
- Cellular – walls form after each division, e.g., Petunia.
- Helobial – partial cell wall formation, e.g., Alisma.

Apomixis: -

Asexual reproduction without fertilization, producing seeds. Replaces normal sexual reproduction.

Types:

- Adventive embryony – embryos from somatic cells of ovule (e.g., Citrus).
- Apospory – embryo sac from nucellus/integral cells, not MMC.
- Diplospory – MMC forms embryo sac without meiosis.

Importance:

- Fixes hybrid vigor.
- Ensures uniform progeny.
- Useful in plant breeding.

Polyembryony: -

Development of multiple embryos in one ovule.

Causes:

- Cleavage polyembryony – zygote divides into many.
- Adventive – additional embryos from nucellus/integruments.
- Multiple embryo sacs – more than one functional sac.
- Examples: Citrus, Mango, Onion.

576. The microsporangium is commonly known as:
a) Ovule
b) Anther
c) Pollen grain
d) Embryo sac

Answer: b) Anther

577. The outermost layer of the microsporangium is called:
a) Tapetum
b) Endothecium
c) Epidermis
d) Middle layer

Answer: c) Epidermis

578. Tapetum provides nutrition to:
a) Integuments
b) Ovule
c) Developing pollen grains
d) Endosperm

Answer: c) Developing pollen grains

579. The process of formation of microspores is known as:
a) Megasporogenesis
b) Microsporogenesis
c) Fertilization
d) Embryogenesis

Answer: b) Microsporogenesis

580. Each microspore mother cell divides by:
a) Mitosis
b) Meiosis
c) Amitosis
d) Cytokinesis only

Answer: b) Meiosis

581. The megasporangium is also known as:
a) Ovary
b) Ovule
c) Anther

d) Pollen sac

Answer: b) Ovule

582. The protective envelopes of the ovule are called:
a) Integuments
b) Funicle
c) Hilum
d) Chalaza

Answer: a) Integuments

583. The point of attachment of ovule to placenta is called:
a) Chalaza
b) Micropyle
c) Funicle
d) Hilum

Answer: c) Funicle

584. Orthotropous ovule is characterized by:
a) Straight ovule with micropyle, chalaza and funicle in line
b) Inverted ovule
c) Curved ovule
d) Campylotropous structure

Answer: a) Straight ovule

585. The process of formation of megaspores is called:
a) Microsporogenesis
b) Megasporogenesis
c) Pollination
d) Fertilization

Answer: b) Megasporogenesis

586. Number of functional megaspores formed in monosporic development:
a) 1
b) 2
c) 3
d) 4

Answer: a) 1

587. Typical type of female gametophyte in Angiosperms is:
a) Tetrasporic
b) Bisporic

c) Monosporic
d) Polysporic

Answer: c) Monosporic

588. The female gametophyte in angiosperms is also known as:
a) Ovule
b) Embryo sac
c) Pollen grain
d) Endosperm

Answer: b) Embryo sac

589. Number of nuclei in a mature embryo sac:
a) 4
b) 6
c) 7
d) 8

Answer: d) 8

590. Synergids are found in:
a) Chalazal end
b) Micropylar end
c) Middle part
d) Endosperm

Answer: b) Micropylar end

591. In autogamy, pollination occurs:
a) Between flowers of two plants
b) Between different flowers of same plant
c) Within the same flower
d) None of the above

Answer: c) Within the same flower

592. Pollination by insects is called:
a) Anemophily
b) Entomophily
c) Hydrophily
d) Ornithophily

Answer: b) Entomophily

593. Pollination by water is termed as:

a) Hydrophily
b) Anemophily
c) Zoophily
d) Entomophily

Answer: a) Hydrophily

594. The transfer of pollen from anther to stigma of different flower of same plant is:
a) Autogamy
b) Geitonogamy
c) Xenogamy
d) Self-pollination

Answer: b) Geitonogamy

595. Pollen tube enters ovule through micropyle in:
a) Porogamy
b) Chalazogamy
c) Mesogamy
d) Syngamy

Answer: a) Porogamy

596. The pollen tube is:
a) Multicellular
b) Single-celled
c) Bicellular
d) Acellular

Answer: b) Single-celled

597. Male gametophyte in angiosperms is:
a) Pollen grain
b) Ovule
c) Embryo sac
d) Endosperm

Answer: a) Pollen grain

598. The male gametophyte is:
a) Haploid
b) Diploid
c) Triploid
d) Tetraploid

Answer: a) Haploid

599. The process of fusion of male and female gametes is:
a) Fertilization
b) Pollination
c) Embryogenesis
d) Endosperm formation

Answer: a) Fertilization

600. The phenomenon of double fertilization was discovered by:
a) Strasburger
b) Nawaschin
c) Hofmeister
d) Brown

Answer: b) Nawaschin

601. Double fertilization results in the formation of:
a) Two embryos
b) Endosperm and embryo
c) Two endosperms
d) None of these

Answer: b) Endosperm and embryo

602. Endosperm is generally:
a) Haploid
b) Diploid
c) Triploid
d) Tetraploid

Answer: c) Triploid

603. Endosperm formed by free nuclear division is:
a) Cellular type
b) Nuclear type
c) Helobial type
d) Simple type

Answer: b) Nuclear type

604. The dicot embryo consists of:
a) One cotyledon
b) Two cotyledons
c) Three cotyledons

d) Four cotyledons

Answer: b) Two cotyledons

605. The monocot embryo has:
a) One cotyledon
b) Two cotyledons
c) Three cotyledons
d) Four cotyledons

Answer: a) One cotyledon

606. In monocots, the single cotyledon is known as:
a) Plumule
b) Radicle
c) Scutellum
d) Coleoptile

Answer: c) Scutellum

607. Polyembryony refers to:
a) Single embryo formation
b) Multiple embryo formation in one seed
c) Formation of multiple seeds
d) Formation of embryo without fertilization

Answer: b) Multiple embryo formation in one seed

608. True polyembryony occurs due to:
a) Fertilization of one egg cell only
b) Fertilization of synergids and antipodal cells
c) Formation of more than one embryo from zygote or other cells
d) Degeneration of embryo

Answer: c) Formation of more than one embryo

609. Apomixis is a type of:
a) Sexual reproduction
b) Asexual reproduction
c) Vegetative propagation
d) Hybridization

Answer: b) Asexual reproduction

610. In apomixis, seeds are formed without:
a) Pollination

b) Fertilization
c) Embryo formation
d) Gamete formation

Answer: b) Fertilization

611. Which of the following is an example of natural apomixis?
a) Mango
b) Citrus
c) Banana
d) Grapes

Answer: b) Citrus

612. The antipodal cells in embryo sac are:
a) Haploid
b) Diploid
c) Triploid
d) Tetraploid

Answer: a) Haploid

613. During embryo development, radicle gives rise to:
a) Shoot
b) Cotyledon
c) Root
d) Fruit

Answer: c) Root

614. The ploidy of primary endosperm nucleus is:
a) n
b) 2n
c) 3n
d) 4n

Answer: c) 3n

615. The chalazogamy type of pollen tube entry is through:
a) Micropyle
b) Chalaza
c) Funicle
d) Hilum

Answer: b) Chalaza

616. Which of the following structures degenerates after fertilization?
a) Zygote
b) Endosperm
c) Synergids
d) Embryo

Answer: c) Synergids

617. In angiosperms, male gametophyte is represented by:
a) Microspore mother cell
b) Pollen grain
c) Ovule
d) Embryo

Answer: b) Pollen grain

618. Which of the following is essential for double fertilization?
a) Only one sperm
b) Two sperm cells
c) Endosperm
d) Pollen tube

Answer: b) Two sperm cells

619. The method of pollination favoured by brightly coloured flowers is:
a) Hydrophily
b) Entomophily
c) Anemophily
d) Zoophily

Answer: b) Entomophily

620. The structure connecting ovule and placenta is called:
a) Hilum
b) Funicle
c) Micropyle
d) Chalaza

Answer: b) Funicle

621. In dicot embryo, plumule develops into:
a) Root
b) Cotyledons
c) Shoot
d) Seed coat

Answer: c) Shoot

622. The first division in microspore mother cell is:
a) Mitotic
b) Meiotic
c) Amitotic
d) Cytokinetic

Answer: b) Meiotic

623. Endosperm development proceeds:
a) Fertilization
b) Embryo development
c) Pollination
d) Zygote formation

Answer: b) Embryo development

624. Anemophily is common in:
a) Orchid
b) Wheat
c) Mango
d) Pea

Answer: b) Wheat

625. The nucleus of the embryo sac formed from functional megaspore is:
a) Diploid
b) Triploid
c) Haploid
d) Tetraploid

Answer: c) Haploid

626. The middle layers of microsporangium degenerate at:
a) Mature pollen stage
b) Tetrad stage
c) Dehiscence stage
d) Microspore mother cell stage

Answer: a) Mature pollen stage

627. In the anther, the innermost layer nourishing developing pollen is:
a) Epidermis
b) Endothecium
c) Tapetum

d) Middle layers

Answer: c) Tapetum

628. The term "anatropous ovule" refers to an ovule:
a) Straight
b) Inverted
c) Curved
d) Upright

Answer: b) Inverted

629. The structure that guides the pollen tube towards the embryo sac is:
a) Funicle
b) Hilum
c) Synergids
d) Chalaza

Answer: c) Synergids

630. Double fertilization leads to the formation of:
a) Two embryos
b) Embryo and endosperm
c) Two endosperms
d) Triploid embryo

Answer: b) Embryo and endosperm

631. The suspensor in dicot embryo:
a) Pushes embryo towards micropyle
b) Nourishes endosperm
c) Develops into radicle
d) Forms cotyledons

Answer: a) Pushes embryo towards micropyle

632. Which type of endosperm development involves both nuclear and cellular characteristics?
a) Nuclear
b) Cellular
c) Helobial
d) Simple

Answer: c) Helobial

633. The chalaza in ovule is situated opposite to:
a) Micropyle

b) Funicle
c) Hilum
d) Nucellus

Answer: a) Micropyle

634. The type of polyembryony occurring due to cleavage of zygote is:
a) Simple
b) Cleavage polyembryony
c) Adventive polyembryony
d) False polyembryony

Answer: b) Cleavage polyembryony

635. Which of the following is an example of vegetative apomixis?
a) Onion
b) Mango
c) Citrus
d) Banana

Answer: a) Onion

636. Micropyle is the opening of ovule through:
a) Hilum
b) Integuments
c) Funicle
d) Nucellus

Answer: b) Integuments

637. In bisporic embryo sac development, the number of meiotic divisions is:
a) One
b) Two
c) Three
d) None

Answer: b) Two

638. In tetrasporic embryo sac development, how many megaspore nuclei contribute to embryo sac formation?
a) 1
b) 2
c) 3
d) 4

Answer: d) 4

639. Synergids are characterized by:
a) Filiform apparatus
b) Thick cell wall
c) Presence of antipodals
d) Triploid nucleus

Answer: a) Filiform apparatus

640. The pollen grains are shed at:
a) 1-nucleate stage
b) 2-nucleate stage
c) 3-nucleate stage
d) 4-nucleate stage

Answer: b) 2-nucleate stage

641. The function of vegetative nucleus in pollen tube is to:
a) Fuse with egg
b) Direct pollen tube growth
c) Form endosperm
d) Degenerate before fertilization

Answer: b) Direct pollen tube growth

642. The term "xenogamy" refers to pollination:
a) Within same flower
b) Between flowers of same plant
c) Between flowers of different plants
d) Without pollen tube formation

Answer: c) Between flowers of different plants

643. Pollen viability refers to:
a) Rate of germination
b) Duration pollen remains functional
c) Rate of pollination
d) Number of pollen grains produced

Answer: b) Duration pollen remains functional

644. In dicot embryo, epiblast is:
a) Rudimentary cotyledon
b) Extra embryonic tissue
c) Embryonic root
d) Embryonic shoot

Answer: b) Extra embryonic tissue

645. Adventive embryony is an example of:
a) True polyembryony
b) False polyembryony
c) Parthenogenesis
d) Somatic embryogenesis

Answer: a) True polyembryony

646. Egg apparatus is made of:
a) Only egg
b) Egg and antipodals
c) Egg and polar nuclei
d) Egg and synergids

Answer: d) Egg and synergids

647. Formation of embryo sac directly from megaspore mother cell in angiosperms is called:
a) Apospory
b) Apogamy
c) Diplospory
d) Agamospory

Answer: c) Diplospory

648. The most common type of ovule in angiosperms is:
a) Orthotropous
b) Anatropous
c) Hemianatropous
d) Circinotropous

Answer: b) Anatropous

649. Double fertilization was first reported by Nawaschin in:
a) Fritillaria
b) Monotrapa
c) Portulaca
d) None of these

Answer: a) Fritillaria

650. Fusion of male gamete with egg (syngamy) was observed in Monotrapa by:
a) Nawaschin

b) Strasburger
c) Schleiden
d) Amici

Answer: b) Strasburger

651. Double fertilization is:
a) Fusion of one male gamete with two polar nuclei
b) Fusion of two male gamete of a pollen tube with two different eggs
c) Syngamy and triple fusion
d) None of the above

Answer: c) Syngamy and triple fusion

652. A dithecous anther have, how many microsporangia?
a) 1
b) 2
c) 4
d) Many

Answer: c) 4

653. Caruncle is derived from:
a) Peduncle
b) Cotyledon
c) Integument
d) None of these

Answer: c) Integument

654. The normal or polygonum type of embryo sac is:

a) Monosporic four nucleated
b) Bisporic eight nucleated
c) Tetrasporic eight nucleated
d) Monosporic eight nucleated

Answer: d) Monosporic eight nucleated

655. A typical angiospermic embryo sac is usually:
a) One celled
b) Two celled
c) Four celled
d) Seven celled

Answer: d) Seven celled

656. When male and female parts of a flower mature at different times, it is called:

a) Monocliny
b) Dicliny
c) Dichogamy
d) Herkogamy

Answer: c) Dichogamy

657. Pollination through Lever Mechanism takes place in:
a) Calotropis
b) Salvia
c) Ficus
d) Hydrilla

Answer: b) Salvia

658. Breaking of the seed coat barriers is called:
a) Abscission
b) Stratification
c) Parthenocarpy
d) Scarification

Answer: d) Scarification

659. Monosporic type of embryo sac development is found in:
a) Lilium type
b) Allium type
c) Oenothera type
d) Fritillaria type

Answer: c) Oenothera type

UNIT-VIII: Palynology

Palynology

Palynology is the branch of science concerned with the study of pollen grains, spores, and other acid-resistant microscopic plant structures (palynomorphs). It encompasses both modern (recent) and fossil pollen and spores, thus bridging botany, geology, and forensic science.

Pollen Structure: -

Pollen grains are highly specialized structures that carry the male gametes in seed plants.

Basic Parts of a Pollen Grain:

- Exine: The outer wall, highly durable and made of sporopollenin. Resistant to decay, enzymes, and chemicals. Shows surface sculpturing used in taxonomy. Has apertures (colpi or pores) for pollen tube emergence. Layers: tectum, columella, foot layer.
- Intine: Inner wall, made of pectin and cellulose. It is delicate and participates in pollen tube formation.
- Apertures: Openings in exine for germination.
- Classified based on number and type: Colpate (furrows), Porate (pores), or combinations.

Pollen Morphology: -

The morphology of pollen varies greatly and is crucial in palynological studies.

Key Characters:

- Size: Typically, 10–200 µm; varies by species.
- Shape: Spherical, ellipsoidal, oblate, prolate, triangular, or irregular.
- Symmetry: Radial (actinomorphic), bilateral (zygomorphic), or asymmetrical.
- Apertures: Monocolpate: One longitudinal furrow (e.g., monocots). Tricolpate: Three furrows (e.g., dicots). Triporate, Pantoporate: Circular pores all around (common in advanced angiosperms).
- Exine Ornamentation: Reticulate (net-like), Echinate (spiny), Psilate (smooth), Striate, Granulate, etc. Important for identifying plant families and genera.

Pollen Allergy: -

Pollen allergy refers to hypersensitive immune reactions caused by inhalation of allergenic pollen grains. Wind-pollinated (anemophilous) plants produce large quantities of light, dry pollen easily inhaled.

Common Allergenic Plants:

- Grasses: Poaceae (e.g., Cynodon, Dactylis)
- Trees: Morus (mulberry), Prosopis, Acacia
- Weeds: Parthenium (Congress grass), Chenopodium, Amaranthus

Applied Palynology: -

Applied palynology uses pollen data to solve problems in geology, taxonomy, medicine, crime investigation, and environmental science.

Palaeopalynology

The study of fossilized pollen and spores from geological deposits.

- Applications:
  - Reconstructing past climates and vegetation (paleoclimate & paleoecology).
  - Dating of geological strata (biostratigraphy).
  - Exploration of fossil fuels:
  - Helps identify ancient swamp conditions indicating coal deposits.
  - Useful in locating petroleum reservoirs through palynological zones.
  - Studied using acid maceration, sieving, centrifugation, and light or SEM microscopy.

Aeropalynology

Study of airborne pollen and spores suspended in the atmosphere.

- Applications:
  - Monitor the concentration of pollen and fungal spores in the air.
  - Predict and prevent seasonal allergic reactions.
  - Support the construction of pollen calendars.
  - Helps in weather forecasting and ecosystem monitoring.

Forensic Palynology: -

Use of pollen and spore analysis in criminal and civil investigations.

Principle:

- Pollen is ubiquitous, microscopic, resistant, and often location-specific.
- Pollen may adhere to clothes, hair, shoes, or objects.

Applications:

- Determine the geographic origin of items or bodies.
- Link a suspect to a crime scene.
- Reconstruct movement of persons or vehicles.
- Verify authenticity of documents, artworks, or food products.

Role of Palynology in Taxonomic Evidence: -

Palynological traits are genetically controlled, stable, and species-specific, providing vital data in systematics.

Applications:

- Classifying plant species based on pollen characters.
- Understanding evolutionary relationships among taxa.
- Solving taxonomic controversies, e.g., placement of ambiguous genera.
- Identifying fossil plants when vegetative/reproductive structures are not preserved.

Examples:

- Tricolpate pollen supports evolutionary advancement in dicots.
- Monocolpate pollen suggests primitiveness, as seen in monocots and some early angiosperms.
- Exine ornamentation used to distinguish closely related species (e.g., in Asteraceae, Malvaceae).

660. The study of pollen and spores is known as:
a) Cytology
b) Palynology
c) Taxonomy
d) Phycology

Answer: b) Palynology

661. The outermost layer of the pollen wall is called:
a) Endexine
b) Intine
c) Exine
d) Perisperm

Answer: c) Exine

662. The pollen exine is primarily composed of:
a) Cutin
b) Sporopollenin
c) Cellulose
d) Lignin

Answer: b) Sporopollenin

663. The thin, inner wall of the pollen grain is called:
a) Exine
b) Intine
c) Perine
d) Endospore

Answer: b) Intine

664. The germination of pollen grain occurs through:
a) Apertures
b) Nucleus
c) Endosperm
d) Mitochondria

Answer: a) Apertures

665. Pollen grains with three furrows or pores are termed as:
a) Monosulcate
b) Tricolpate
c) Tetrad
d) Pollen sac

Answer: b) Tricolpate

666. Which type of pollen aperture is found in monocots?
a) Monocolpate
b) Tricolpate
c) Tricolporate
d) Triporate

Answer: a) Monocolpate

667. The pollen shape can be studied using which microscopic technique?
a) Phase contrast microscopy
b) Scanning electron microscopy
c) Fluorescence microscopy
d) Confocal microscopy

Answer: b) Scanning electron microscopy

668. Pollen tube emerges through the:
a) Sporoderm
b) Intine
c) Exine
d) Pore or furrow

Answer: d) Pore or furrow

669. The chemical responsible for pollen viability is:
a) Lipids
b) Proteins
c) Enzymes
d) Carbohydrates

Answer: a) Lipids

670. Hay fever is caused by:
a) Fungi
b) Pollen grains
c) Viruses
d) Bacteria

Answer: b) Pollen grains

671. Which pollen grains are most allergenic?
a) Large-sized, heavy pollen
b) Small-sized, light pollen
c) Wet pollen

d) Seed-borne pollen

Answer: b) Small-sized, light pollen

672. The major cause of seasonal allergic rhinitis is:
a) Ragweed pollen
b) Oak pollen
c) Pine pollen
d) Fern spores

Answer: a) Ragweed pollen

673. The study of pollen allergy falls under:
a) Aerobiology
b) Embryology
c) Mycology
d) Pharmacology

Answer: a) Aerobiology

674. Which of the following methods helps reduce pollen allergies?
a) Staying indoors during high pollen seasons
b) Using antihistamines
c) Wearing masks outdoors
d) All of the above

Answer: d) All of the above

675. Palynology is useful in:
a) Taxonomy
b) Medicine
c) Oil exploration
d) All of the above

Answer: d) All of the above

676. Pollen analysis is useful in solving:
a) Criminal cases
b) Weather forecasting
c) Genetic disorders
d) Soil erosion

Answer: a) Criminal cases

677. Honey pollen analysis is known as:
a) Melissopalynology

b) Aeropalynology
c) Forensic palynology
d) Palaeopalynology

Answer: a) Melissopalynology

678. In forensic investigations, palynology is used to:
a) Identify suspects' locations
b) Determine cause of death
c) Analyze food poisoning cases
d) Detect bacterial infections

Answer: a) Identify suspects' locations

679. Which industry benefits from palynology in hydrocarbon exploration?
a) Automobile industry
b) Petroleum industry
c) Textile industry
d) Pharmaceutical industry

Answer: b) Petroleum industry

680. The study of ancient pollen and spores is called:
a) Forensic botany
b) Palaeopalynology
c) Ethnobotany
d) Cytogenetics

Answer: b) Palaeopalynology

681. The preservation of fossil pollen is enhanced in:
a) Dry environments
b) Acidic bogs
c) Salty lakes
d) Cold climates

Answer: b) Acidic bogs

682. Forensic palynology helps in:
a) Determining the season of death
b) Identifying geographical origin
c) Linking suspects to crime scenes
d) All of the above

Answer: d) All of the above

683. Which of the following is NOT a method used in forensic palynology?
a) Light microscopy
b) SEM analysis
c) DNA fingerprinting
d) Pollen fingerprinting

Answer: c) DNA fingerprinting

684. Pollen grains remain preserved in sediments due to:
a) High lignin content
b) Sporopollenin resistance
c) High water absorption
d) Low cellulose content

Answer: b) Sporopollenin resistance

685. Palynology helps in plant taxonomy by:
a) Studying pollen morphology
b) Identifying fossil plants
c) Determining evolutionary relationships
d) All of the above

Answer: d) All of the above

686. The family characterized by tricolpate pollen is:
a) Poaceae
b) Lamiaceae
c) Asteraceae
d) Brassicaceae

Answer: d) Brassicaceae

687. Monocolpate pollen is a characteristic of:
a) Dicotyledons
b) Monocotyledons
c) Gymnosperms
d) Bryophytes

Answer: b) Monocotyledons

688. Pollen morphology can be used to distinguish between:
a) Angiosperms and gymnosperms
b) Prokaryotic and eukaryotic cells
c) Mammals and amphibians
d) Bacteria and viruses

Answer: a) Angiosperms and gymnosperms

689. The evolutionary significance of pollen studies is mainly due to:

a) Sporopollenin resistance
b) Genetic variation
c) Seed dormancy
d) Fruit development

Answer: a) Sporopollenin resistance