CLASS 11 BIOLOGY NCERT SOLUTIONS

NCERT Solutions for Class 11 Biology Chapter 3: Plant Kingdom – Free PDF Download

Chapter 3, Plant Kingdom, takes the broad five-kingdom framework from Chapter 2 and zooms into Plantae, walking through algae, bryophytes, pteridophytes, gymnosperms and angiosperms in order of increasing structural complexity. Along the way it explains how reproductive strategies changed as plants moved from water ...

Contents

Chapter 3, **Plant Kingdom**, takes the broad five-kingdom framework from Chapter 2 and zooms into *Plantae*, walking through algae, bryophytes, pteridophytes, gymnosperms and angiosperms in order of increasing structural complexity. Along the way it explains how reproductive strategies changed as plants moved from water onto land – from motile, water-dependent gametes in algae and bryophytes to the pollen tube and naked seed of gymnosperms. These Class 11 Biology Chapter 3 solutions are also useful as quick revision notes before exams.

Exercises

Q1. What is the basis of classification of algae?

Algae are classified mainly on the basis of three features: the **type of pigments** they contain (which decides their colour), the **chief form of stored food**, and the **constitution of the cell wall**. The number, position and point of insertion of **flagella** on the motile cells is also used as a criterion. Using these features, algae are grouped into three classes:

Chlorophyceae (green algae) – contain chlorophyll *a* and *b*, store food as starch, have a cellulose-pectose cell wall, and usually bear 2-8 equal, apically inserted flagella. Examples: *Chlamydomonas*, *Volvox*, *Ulothrix*, *Spirogyra*.
Phaeophyceae (brown algae) – contain chlorophyll *a* and *c* plus the brown pigment fucoxanthin, store food as mannitol or laminarin, and have motile cells with 2 unequal, laterally inserted flagella. Examples: *Ectocarpus*, *Laminaria*, *Fucus*, *Sargassum*.
Rhodophyceae (red algae) – contain chlorophyll *a* and *d* along with the red pigment r-phycoerythrin, store food as floridean starch, and generally lack flagella altogether. Examples: *Polysiphonia*, *Porphyra*, *Gracilaria*.

Q2. When and where does reduction division take place in the life cycle of a liverwort, a moss, a fern, a gymnosperm and an angiosperm?

In every case, reduction division (**meiosis**) occurs in the diploid **sporophyte**, inside the structure that produces spores or spore-like cells:

Liverwort: meiosis occurs in the spore mother cells inside the capsule of the sporophyte, producing haploid spores.
Moss: as in liverworts, meiosis takes place in the spore mother cells within the capsule of the sporophyte to form haploid spores.
Fern: meiosis occurs in the spore mother cells inside the sporangia, which are borne on the sporophylls of the sporophyte, giving rise to haploid spores.
Gymnosperm: meiosis occurs twice – in the microspore mother cells inside the microsporangia (borne on microsporophylls) to form microspores/pollen, and in the megaspore mother cell inside the megasporangium (the nucellus of the ovule) to form megaspores.
Angiosperm: similarly, meiosis occurs in the microspore mother cells inside the anther to form pollen grains (microspores), and in the megaspore mother cell inside the ovule to form megaspores, one of which develops into the embryo sac.

Q3. Name three groups of plants that bear archegonia. Briefly describe the life cycle of any one of them.

The three groups that bear archegonia (flask-shaped female sex organs) are **bryophytes, pteridophytes and gymnosperms**.

Life cycle of a moss (a bryophyte): The dominant, photosynthetic plant body is the haploid **gametophyte**. A germinating spore first grows into a creeping, filamentous **protonema**, from which an upright, leafy gametophore develops as a lateral bud. This leafy shoot bears the sex organs at its apex – the **antheridium**, which produces biflagellate, motile **antherozoids**, and the flask-shaped **archegonium**, which produces a single non-motile **egg**. Because the antherozoids must swim through a film of water to reach the egg, fertilisation is water-dependent. Fusion of the antherozoid and egg forms a diploid **zygote**, which does not divide meiotically at once; instead it develops into a multicellular **sporophyte** differentiated into a foot, seta and capsule. The sporophyte remains permanently attached to, and nutritionally dependent on, the parent gametophyte. Inside the capsule, spore mother cells undergo meiosis to produce haploid **spores**, which are dispersed and germinate to form a new protonema, completing the cycle.

Q4. Mention the ploidy of the following: protonemal cell of a moss; primary endosperm nucleus in dicot; leaf cell of a moss; prothallus cell of a fern; gemma cell in *Marchantia*; meristem cell of monocot; ovum of a liverwort; and zygote of a fern.

Protonemal cell of a moss – haploid (n), since it is part of the gametophyte.
Primary endosperm nucleus in a dicot – triploid (3n), formed by the fusion of one male gamete with the two polar nuclei (triple fusion).
Leaf cell of a moss – haploid (n), because the leafy moss plant is gametophytic.
Prothallus cell of a fern – haploid (n), as the prothallus is the free-living fern gametophyte.
Gemma cell in *Marchantia* – haploid (n), since gemmae are asexual buds produced on the haploid gametophyte thallus.
Meristem cell of a monocot – diploid (2n), as it belongs to the sporophyte plant body.
Ovum of a liverwort – haploid (n), being a gamete produced by the gametophyte.
Zygote of a fern – diploid (2n), formed by fusion of the male gamete and the egg.

Q5. Write a note on economic importance of algae and gymnosperms.

Economic importance of algae: Algae carry out roughly half of all carbon dioxide fixation on Earth through photosynthesis and raise the level of dissolved oxygen in their surroundings, making them vital primary producers at the base of aquatic food chains. Several species of *Porphyra*, *Laminaria* and *Sargassum* are eaten directly as food. Certain brown and red algae yield commercially valuable hydrocolloids – **algin** from brown algae and **carrageen** from red algae – used as thickening and stabilising agents. **Agar**, extracted from *Gelidium* and *Gracilaria*, is used to culture microorganisms in the laboratory and in preparing ice-creams and jellies. The protein-rich unicellular alga *Chlorella* is used as a food supplement, including by space travellers.

Economic importance of gymnosperms: Gymnosperm wood (softwood) is an important source of timber and paper pulp. Resin and turpentine are obtained from conifers such as *Pinus*. Several gymnosperms (*Cedrus*, *Pinus*, *Cycas*, *Thuja*) are grown as ornamental garden plants, and edible seeds are obtained from genera such as *Pinus* (chilgoza/pine nuts) and *Gnetum*.

Q6. Both gymnosperms and angiosperms bear seeds, then why are they classified separately?

Although both groups reproduce by seeds, they differ fundamentally in how the seeds are formed and protected:

In **gymnosperms**, the ovules are not enclosed by any ovary wall – they remain exposed (naked) both before and after fertilisation, so the resulting seeds are also naked, without a fruit around them. There is no true flower and, consequently, no double fertilisation; only a single fusion between the male gamete and the

egg occurs, and the nutritive tissue surrounding the embryo is the haploid female gametophyte formed before fertilisation.

In **angiosperms**, the ovules develop inside an enclosed ovary, and pollen and ovules are borne in specialised structures called flowers. Fertilisation is a **double fertilisation** event: one male gamete fuses with the egg to form the diploid zygote, and a second male gamete fuses with the two polar nuclei to form the triploid primary endosperm nucleus, which develops after fertilisation. After fertilisation, the ovary matures into a fruit that encloses and protects the seeds. These deep differences in ovule exposure, fertilisation and seed protection justify treating gymnosperms and angiosperms as separate groups.

Q7. What is heterospory? Briefly comment on its significance. Give two examples.

Heterospory is the phenomenon in which a plant produces two morphologically different kinds of spores – smaller **microspores**, which give rise to the male gametophyte, and larger **megaspores**, which give rise to the female gametophyte – instead of a single, uniform type of spore. Among pteridophytes, *Selaginella* and *Salvinia* are heterosporous.

Significance: In heterosporous plants, the megaspore is often retained within the megasporangium, and the female gametophyte that develops from it, along with the young embryo formed after fertilisation, remains attached to and nourished by the parent sporophyte. This retention of the female gametophyte and developing embryo on the parent plant is considered an important evolutionary precursor to the **seed habit** seen in gymnosperms and angiosperms. Heterospory also promotes cross-fertilisation, since male and female gametophytes develop separately from distinct spore types.

Q8. Explain briefly the following terms with suitable examples:

(i) Protonema – The first, thread-like or filamentous stage in the life cycle of a moss, which develops directly upon germination of a haploid spore. It is green, creeping and branched, and eventually produces bud-like lateral outgrowths that grow into the leafy gametophore, e.g., in *Funaria*.

(ii) Antheridium – The multicellular male sex organ found in bryophytes and pteridophytes. It produces numerous biflagellate, motile male gametes called **antherozoids**, which require water to swim to the archegonium, e.g., in *Marchantia* and *Funaria*.

(iii) Archegonium – The multicellular, flask-shaped female sex organ of bryophytes, pteridophytes and gymnosperms, differentiated into a narrow neck and a swollen venter. It produces a single, non-motile egg, e.g., in *Funaria* and ferns.

(iv) Diplontic – A type of life cycle in which the diploid **sporophyte** is the dominant, independent, free-living phase; meiosis occurs at the time of gamete formation (gametic meiosis), so the gametes are the only haploid cells in the entire cycle. This pattern is characteristic of most animals and, among plants, is approached in gymnosperms and angiosperms, where the sporophyte is dominant and the gametophyte generation is highly reduced.

(v) Sporophyll – A leaf, often modified, that bears sporangia. A sporophyll bearing microsporangia is called a **microsporophyll**, and one bearing megasporangia is a **megasporophyll**. In several pteridophytes and in gymnosperms, sporophylls are arranged compactly along an axis to form cone-like structures called **strobili**, e.g., in *Selaginella* and *Pinus*.

(vi) Isogamy – A type of sexual reproduction in which the fusing male and female gametes are morphologically similar in size and shape; they may be flagellated (motile), as in *Ulothrix*, or non-flagellated

(non-motile), as in *Spirogyra*.

Q9. Differentiate between the following:

(i) Red algae and brown algae – Red algae (Rhodophyceae) contain chlorophyll *a* and *d* along with the pigment r-phycoerythrin, which gives them their red colour; they store food as floridean starch and largely lack flagellated cells. Brown algae (Phaeophyceae) contain chlorophyll *a* and *c* along with the pigment fucoxanthin, which gives them an olive-to-brown colour; they store food as mannitol or laminarin, and their reproductive cells are biflagellate. Red algae (e.g., *Porphyra*, *Polysiphonia*) are found in both shallow and deep marine waters, while brown algae (e.g., *Ectocarpus*, *Fucus*, *Laminaria*) are found almost exclusively in marine habitats near the surface.

(ii) Liverworts and moss – In liverworts the gametophyte thallus is flat, dorsiventral and prostrate (e.g., *Marchantia*), there is no protonema stage, and asexual reproduction commonly occurs through gemmae formed in gemma cups. In mosses the gametophyte passes through two distinct stages – a creeping, filamentous **protonema** followed by an upright, leafy **gametophore** (e.g., *Funaria*) – and the sporophyte is more elaborate, with a specialised mechanism (the peristome) for spore dispersal from the capsule.

(iii) Homosporous and heterosporous pteridophyte – Homosporous pteridophytes produce only one kind of spore, which is uniform in size and gives rise to a single type of bisexual gametophyte bearing both antheridia and archegonia, e.g., *Dryopteris*, *Pteris*, *Equisetum*. Heterosporous pteridophytes produce two morphologically distinct kinds of spores – microspores and megaspores – which develop into separate male and female gametophytes; the female gametophyte is retained on the parent sporophyte, foreshadowing the seed habit, e.g., *Selaginella*, *Salvinia*.

Q10. Match the following (Column I with Column II).

The correct matches are: **(a) *Chlamydomonas* – (iii) Algae; (b) *Cycas* – (iv) Gymnosperm; (c) *Selaginella* – (ii) Pteridophyte; (d) *Sphagnum* – (i) Moss.** *Chlamydomonas* is a unicellular green alga; *Cycas* is a gymnosperm bearing naked seeds; *Selaginella* is a heterosporous pteridophyte; and *Sphagnum* (peat moss) is a bryophyte belonging to the mosses.

Q11. Describe the important characteristics of gymnosperms.

Gymnosperms (*gymnos*: naked, *sperma*: seed) are seed-bearing plants whose ovules and seeds are not enclosed within an ovary wall and remain exposed both before and after fertilisation. Their important characteristics are:

They include medium to tall trees and shrubs, generally with a well-developed **tap root** system; some genera show specialised root associations, such as **mycorrhiza** in *Pinus* and **coralloid roots** housing nitrogen-fixing cyanobacteria in *Cycas*. The stem may be unbranched (*Cycas*) or branched (*Pinus*, *Cedrus*), and leaves may be simple or pinnately compound, often adapted to reduce water loss through a thick cuticle, sunken stomata and needle-like shape (as in conifers). Gymnosperms are **heterosporous**, producing haploid microspores and megaspores within sporangia borne on sporophylls that are arranged spirally to form male (microsporangiate) and female (megasporangiate) **strobili or cones**. The male and female gametophytes are highly reduced and are never free-living – they remain permanently retained within the sporangia on the sporophyte. Pollen grains are usually dispersed by wind, and fertilisation does not require external water because the pollen tube carries the non-motile male gametes directly to the archegonium (a process called **siphonogamy**). Following fertilisation, the zygote develops into an embryo

and the ovule matures into a naked seed.

Class 11 Biology Chapter 3 – Notes and Extra Questions

This chapter's exercise section currently has **11 questions** in the 2023 rationalised NCERT textbook (verified against the official PDF on ncert.nic.in), down from 12 in the pre-2023 edition. As part of the rationalisation, the entire sub-section 3.6, "Plant Life Cycles and Alternation of Generations," was removed from the chapter, section 3.5 (Angiosperms) was trimmed, and two exercise items were dropped from the older question set: the full question "How would you distinguish monocots from dicots?" and the sub-part "differentiate between syngamy and triple fusion" that used to sit inside the differentiate-the-following question. While preparing for exams, focus on comparative tables (algae classes, liverwort vs moss, homosporous vs heterosporous), the sequence in which meiosis occurs across the five groups (Q2), and the ploidy-tracking skill tested in Q4, since these recur frequently as short-answer and assertion-reason questions in school tests and competitive exams alike. Diagram-based recall of a moss or fern life cycle, along with correct spelling of genus names (always italicised), is also commonly rewarded in board answers.

What is the difference between haplontic, diplontic and haplodiplontic life cycles found in plants?

In a **haplontic** life cycle, the haploid gametophyte is the dominant, free-living phase; the zygote is the only diploid cell and it undergoes meiosis immediately upon germination (zygotic meiosis), as seen in algae like *Chlamydomonas* and *Volvox*. In a **diplontic** life cycle, the diploid sporophyte is dominant and free-living, meiosis occurs only during gamete formation (gametic meiosis), and the gametes are the sole haploid cells – a pattern approached by gymnosperms and angiosperms, where the gametophyte is reduced. In a **haplodiplontic** life cycle, both the multicellular haploid gametophyte and the multicellular diploid sporophyte are represented, alternating with each other; meiosis is sporic, occurring in the sporophyte to produce spores that germinate into the gametophyte. This pattern, also called alternation of generations, is seen in bryophytes and pteridophytes.

Why are bryophytes called the "amphibians of the plant kingdom"?

Bryophytes are called amphibians of the plant kingdom because, like amphibian animals, they can live in soil and other terrestrial, moist habitats, but they still depend on a film of external water to complete sexual reproduction. Their motile, flagellated male gametes (antherozoids) must swim through water to reach the egg inside the archegonium, which restricts bryophytes to consistently damp, shaded environments even though the plant body itself grows on land.

What is the main difference between pteridophyte and gymnosperm reproduction?

In pteridophytes, the gametophyte (prothallus) is small but free-living, independent and photosynthetic, and fertilisation still requires external water so that motile antherozoids can swim to the archegonium. In gymnosperms, both the male and female gametophytes are highly reduced and are never free-living – they remain enclosed within the sporangia on the sporophyte. Fertilisation does not need external water because the pollen tube delivers non-motile male gametes directly to the egg, a mechanism called siphonogamy. Gymnosperms also form a true seed (a retained, protected embryo with stored food), whereas most pteridophytes reproduce and disperse only by spores.

Was any content removed from the Plant Kingdom chapter in the 2023 NCERT rationalisation?

Yes. The rationalised (2023) NCERT syllabus removed sub-section 3.6, “Plant Life Cycles and Alternation of Generations,” in its entirety from this chapter, along with parts of section 3.5 (Angiosperms) and the last two paragraphs of the chapter summary. In the exercises, the full question asking students to distinguish monocots from dicots was dropped, and the “syngamy vs triple fusion” sub-part was removed from the differentiate-the-following question, bringing the exercise count down from 12 questions in the older edition to 11 questions in the current textbook.