One way to separate algae from protozoa is that
a. Protozoa are photosynthetic, while algae are not.
b. Algae are photosynthetic, while protozoa are not.
c. Protozoa are prokaryotic, while algae are eukaryotic.
d. Algae have cell walls, while protozoa do not.
e. b and d are correct.

In the life cycle of the kelp *Laminaria*

a. there is a haploid generation, but no diploid generation.
b. multicellular haploid and diploid generations are both present.
c. the gametophyte and sporophyte generations are morphologically similar.
d. mitosis occurs, but not meiosis.
e. a and d are correct.

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Chapter 29. Plant Diversity I. How Plants Colonized Land

Some History:
- The earth is about 4600 million years old
- First traces of life: about 3500 MYA
- First eukaryote fossils: about 2200 MYA
- Fossils of oldest plants: about 500 MYA in rocks of Ordovician age
- $3500 - 500 = 3000$, or 86% of 3500.

Rocks of Devonian Age in Letchworth Gorge

Rocks of Cambrian Age (ca. 510 MYA)
Queenston Shale (Ordovician, ca. 460 MYA)

Land plants evolved from green algae (Charophyceans)

Evidence for a charophycean origin of the land plants:
- Details of cellular structure
- Close similarity in nuclear and chloroplast genes
- Presence of sporopollenin in zygote cell walls

Two Puzzles
- What factors encouraged the colonization of land?
  - Exploitation of ample resources?
- Why did it take so long?
  - Development of ozone (O₃) layer made continents habitable?

Derived Traits of (Land) Plants
- Apical meristems
- Alternation of generations
- Walled spores produced in sporangia
- Multicellular gametangia
- Multicellular, dependent embryos

In plants, growth is localized in apical meristems
Plant life cycles involve alternation of generations

Plants have walled spores produced in sporangia

Plants produce gametes in multicellular gametangia

Plants have multicellular, dependent embryos

Some more traits of (land) plants
- Cuticle – to retard desiccation
- Stomata – to facilitate gas exchange
- Wide range of secondary chemical compounds (e.g. anti-herbivore defenses)
- Vascular tissue (except in bryophytes)

Highlights of plant evolution
A convenient classification of plants

- Bryophytes (non-vascular)
- Vascular plants
  - Seedless vascular plants
    - Lycophytes
    - Pterophytes
  - Seed plants
    - Gymnosperms
    - Angiosperms

Bryophytes, emphasizing mosses

Mosses are generally restricted to moist environments …

… but can also occupy extreme environments

Peat bogs are formed by *Sphagnum*

Bryophyte life cycle is dominated by gametophyte stage
Key points of the bryophyte life cycle

- Gametophyte dominant, sporophyte dependent on it.
- Diploid sporophytes produces spores in sporangia (via meiosis).
- Spores germinate to produce filamentous protonemata.
- Protonemata develop into "leafy" gametophytes.

Key points of the bryophyte life cycle (continued)

- Gametophytes produce gametes in gametangia (via mitosis).
  - Antheridia produce sperms
  - Archegonia produce eggs
- Sperms swim to eggs to effect fertilization
- Fertilization results in a diploid zygote
- Zygote develops into sporophyte

Seedless Vascular Plants

- Alternation of generations in which sporophyte dominates.
- Flagellated sperms.
- Transport in vascular tissue.
  - Xylem transports water and mineral nutrients.
  - Phloem transports sugars and other organic compounds.
- Roots – for anchorage and absorption.
- Leaves – for photosynthesis

Evolution of leaves I. Microphylls

Evolution of leaves II. Megaphylls
Evolution of leaves II. Megaphylls

Alternation of generations: review

Life cycle of a fern

Fern morphology:
- Sporophyte
- Gametophyte
- Rhizome
- Frond (leaf)
- Sorus
- Sporangium

Fern leaves develop toward their tips to produce “fiddleheads”

Tree ferns occur in tropical forests
“Living fossils?”

*Equisetum*  *Psilotum*

“Living fossils”?  

*Lycopodium*

A forest of the Carboniferous period, ca. 300 MYA

*Calamites*, a giant Carboniferous horsetail

*Lepidodendron*, a giant Devonian lycophyte

What about *Psilotum*?

*Aglaphyton*, 420 MYA  *Psilotum*, today