- a small cell has more SA in proportion to its volume and so the interior parts of a small cell are closer to the surrounding env. (the area increases as the square of the radius and the cell's volume increases as the cube of the radius - as the cell size increases, becomes harder to supply the cell)
- few exceptional bacteria - *Thiomargarita namibiensis (*extremely large but 98% of its volume is taken up by a large vacuole thus the distance through which nutrients move by diffusion is still small)
- some bacteria are multicellular, forming simple filaments or sheets of cells. - **myxobacteria** are unusual because they aggregate to form multicellular reproductive structures that are composed of several distinct cell types.
- Bacterial genomes are generally smaller than those of eukaryotes which is beneficial because they can reproduce rapidly. Bacteria do not undergo meiotic cell division and cell fusion as they lack the sexual processes characteristic of eukaryotic organisms.
- Variation - can obtain new genes from distant relatives through **horizontal gene transfer**, a process that is a major source of genetic diversity in bacteria
  - some bacteria synthesize thin strands of membrane bound cytoplasm called pili that connect them to other cells. A pilus provides a migration route for the direct cell to cell transfer of DNA - **conjugation [Fig 26.4a]**
  - DNA released to the environment by cell breakdown can be taken up by other cells - **transformation**
  - Horizontal gene transfer by means of viruses is called **transduction**
- The Archea form a second prokaryotic domain. Cell size in Archea is limited by diffusion and genetic diversity is promoted by horizontal gene transfer like Bacteria. But there are differences - **Table 26.1** Some differences - live in extreme environments, DNA trancription is more similar to eukaryotes than to bacteria

26.2 An Expanded Carbon Cycle

- In photosynthetic eukaryotes, the photosynthetic reaction is **oxygenic** or oxygen producing. Why? Because water occurs everywhere and in the O2 rich env. where most euk. organisms thrive, no other molecule is available to donate electrons other than water (when water is oxidized, it becomes O2). Similarly, all respiration is **aerobic** or oxygen utilizing for eukaryotic organisms
- where O2 is limited or absent, other electron donors are available for photosynthesis and other electron acceptors can be used for respiration. The organisms that can use these alternative options are Bacteria abnd Archea
- carpets of deep blue-green covering tidal flats - **microbial mats** which are densely packed communities of bacteria and archeons that thrive where animals and seaweeds cannot grow. The top surface of a microbial mat - cyanobacteria (similar carbon cycle as eukaryotes) Beneath the mat surface - O2 depleted and light reduced - carbon dioxide is still reduced to carbs though by **anoxygenic photosynthetic bacteria**, harvest light energy to drive the synthesis of carbohydrates but do not gain electrons from water and so do not generate oxygen gas.

33.2 Bryophytes

- Liverworts, mosses, and hornworts are referred to as **bryophytes** - paraphyletic group.
- the first plant lineages to diverge after plants moved to land. **Fig 33.1**
- diverged before the evolution of lignified xylem
- Mosses are the most widely distributed of the bryophyte lineages and the most diverse. Liverworts and hornworts are less widespread and less diverse.
- Common features:
- they are small- the major constraint on bryophyte size is thought to arise from their mode of fertilization. Bryophytes release their sperm into the environment and these sperm must swim but can only travel a short distance.
- they have simple bodies; some produce only a flattened photosynthetic structure called a **thallus**. Others have leaf life structures that are different from leaves of vascular plants in that they are only one to several cells thick and lack internal air spaces or a water conducting system. Both thalloid and leafy species=liverworts; leafy=mosses;thalloid=hornworts
- These bodies represent the haploid generation. A key innovation that appeared in the land plants is the alternation b/w a multicellular gamete producing generation composed entirely of haploid cells and a multicellular spore-producing generation composed of diploid cells. It is the diploid, spore producing generation that represents a new component of the life cycle that evolved as plants moved to land.
- In bryophytes, the sporophyte remains physically attached to the gametophyte. In mosses and liverworts, the sporophyte is short lived, drying out after the spores are dispersed but in hornworts, they live as long as teh gametophyte. Thus, bryophytes illustrate the trend in the evolution of plants, an increase in the persistence of the spore producing generation. **Fig 33.3**
- Because byophytes do not produce lignified xylem conduits, they cannot pull water from the soil. Instead, they absorb water and CO_2 through their surfaces.
- Many bryophytes live on the branches and trunks of trees rather than the ground. **Epiphytes**= plants that grow on other plants. They can do this b/c they are not dependent upon the soil as a source of water.
- Although Bryophytes are so diff. than vascular plants, given that they have long evolved in parallel with vascular plants, they still evolved similar solutions to environmental challenges- convergent evolution. EX. some mosses depend on insects to transport their spores; presence of cells specialized for the transport of water and carbs - these cells evolved independently from the xylem and phloem of vascular plants as cells in bryophytes don't have lignified cell walls and thus aren't sufficiently rigid to pull water from the soil. Nevertheless, water and carbs can move more throughout the plant. Presence of stomata is another example.
- bryophytes make only a small contribution to the total biomass in most ecosystems. The one exception is **peat bogs**, wetlands in which dead organic matter accumulates. A major component of peat bogs is sphagmum moss.

33.3 Spore-Dispersing Vascular Plants

the way monocots form roots - they continuously initiate new roots from their stems making the roots similar to those found in ferns and lycophytes. Monocot flowers typically produce organs in multiples of 3 whereas eudicots forms in multiples of 4/5. Monocots do not produce wood

- Eudicots - appeared in fossil record 125 MYA, today making up 3/4 of all angiosperm species. Eudicots are well represented in the fossil record b/c their pollen is easily distinguished : each eudicot pollen has three opening from which the pollen tube can grow whereas pollen in all other seed plants has only a single opening. Eudicots have two cotyledons but b/c all early angiosperm lineages also have 2, these are the "true" dicots. Many eudicots produce highly conductive xylem, high rates of water transport, and high rates of photosynthesis - rainforest trees.
- Herbaceous eudicots - do not form woody stems; instead, the aboveground shoot dies back each year rather than withstand a period of drought /cold. At the extreme are annuals, herbaceous plants that complete their life cycle in less than a year, persisting during the unfavorable period as seeds. Annuals are unique to angiosperms and almost entirely eudicots. Why are eudicots successful as herbs and trees? - the ability to produce highly conductive xylem may allow herbaceous eudicots to grow quickly and to produce inexpensive and thus easily replaced stems. Most parasitic plants and virtually all carnivorous plants are eudicots.
- **Fig 33.26**

Chapter 30 Plant Reproduction

30.1 Plant Reproduction

- Early land plants evolved a life cycle in which one generation, or phase of the life cycle, released sperm into a moist environment and the following generation dispersed offspring through the air. It was only with the evolution of pollen and seeds that plants no longer depended on external sources of water for fertilization.
- **Fig 30.1** two groups of green algae are most closely related to land plants. *Coleochaete* and *Chara* - like all sexually reproducing eukaryotes, these algae alternate b/w a diploid(2n) phase and a haploid(1n) phase. In animals, the multicellular body consists of diploid cells. Coleochaete and chara have a multicellular body as well but it only consists of haploid cells. Specialized cells of the haploid body produce haploid eggs and sperm by mitosis - the egg is retained and the sperm, released in water. Fertilization forms a diploid zygote which then undergoes meiosis to produce haploid cells that give rise to a new multicellular haploid generation (**Fig30.3)** The haploid products of meiosis then disperse by swimming or by the zygote dispersing itself and undergoing meiosis in the water
- In Chara and Coleaochaete, both fertilization and dispersal take place in water. However, in a drought, the algae survive b/c their zygote forms a protective wall(the condition form which the more complicated life cycles of land plants evolved)

- As plants moved to land - life cycle pulled them in two directions = fertilization required plants remain near the ground where water is found while dispersal requires tall heights, away from that water.
- Ex. a moss *Polytrichyum*. Like the algae, this moss has a photosynthetic body made of haploid cells that forms gametes by mitotic division and in which the fusion of egg and sperm gives rise to a diploid zygote. But then, in the moss, the zygote does not undergo meiosis but is retained in the female reproductive organ, where it divides by mitosis to produce a new diploid multicellular generation. Some cells within this body undergo meiosis to form haploid **spores**, cells that disperse and give rise to a new haploid generation. B/c the diploid multicellular generation gives rise to spores = **sporophyte** and b/s the haploid multicellular generation gives rise to gametes=**gametophyte (Fig 30.4)** The resulting life cycle, in which a haploid gametophyte and a diploid sporophyte follow one after the other, is called **alternation of generations** and describes the basic life cycle of all land plants.
- Because the fertilized egg was retained within the female reproductive organ, the sporophyte grows directly out of the gametophyte's body. The gametophyte is photosynthetically self-sufficient. In contrast, the sporophyte obtains water and nutrients needed for its growth from the gametophyte. The multicellular sporophyte enhances the ability of plants to disperse on land. The capsule at the top of the sporophyte is a **sporangium**, a structure in which many thousands of cells undergo meiosis, producing large numbers of haploid spores. The sporangia release their spores only when the air is dry.
- The algae secrete a wall that protects the zygote within from desiccation. this wall contain **sporopollenin**, a complex mixture of polymers that is resistant to environmental stress. In mosses and other land plants, it is the spore, not the zygote, that secretes sporopollenin. Like their ancestors, mosses and other bryophytes rely on water to transport sperm to egg.
- The first two lineages of vascular plants - lycophytes and the ferns and horsetails- depend on swimming sperm and disperse spores in air like bryophytes. However, xylem and phloem occur in the sporophyte generation --> difference: in byophytes it is the gametophyte that's the photosynthetic generation, while in vascular plants it is the sporophyte generation that dominates in both physical size and photosynthetic output.
- **Fig 30.6** --> life cycle of the fern. Sporangia, tiny brown packets, contain diploid cells that undergo meiosis to generate haploid spores. As in mosses, the spores become covered by a thick wall of sporopollenin. Spores germinate to produce the haploid gametophyte generation. Chemical signals released by gametophytes producing females eggs stimulate gametophytes nearby to produce male gametes that swim to the egg through a film of water. However, they can also produce both gametes. The union forms a diploid zygote which forms leaves and roots that allow it to become a physiologically independent, diploid sporophyte. Ferns and other spore dispersing plants (lycophytes, horsetails, and bryophytes) release swimming sperm.
- Seed Plants eliminate the req. of water. Pollen grains are produced by all seed plants. It's the evolution of pollen that liberated seed plants from the need to release swimming sperm into the environment. Pollen allows the sperm producing gametophyte to be transported in the air.