Nonvascular Plants

Characteristics of Nonvascular Plants

Eukaryotic

Multi-celled (with cell walls composed of cellulose)

Autotrophic

Do not have xylem and phloem

Do not produce seeds

Do not produce flowers or fruits

The Groups of Nonvascular Plants

Liverworts

Hornworts

Mosses

Meiosis and Fertilization

Diploid ($2n$) organisms have pairs of chromosomes (e.g., humans have 23 pairs of chromosomes for a total of 46; there are two number one chromosomes, two number two chromosomes, etc.)

Meiosis is the process by which the chromosomes of pairs in diploid ($2n$) cells are separated from one another and haploid (n) cells are produced (e.g., in humans, meiosis will give rise to cells with 23 chromosomes, one from each pair)

Fertilization is the process by which two haploid (n) gametes (sex cells) fuse to produce a diploid ($2n$) zygote

By definition, gametes are haploid (n) and zygotes are diploid ($2n$)

Mitosis

Mitosis is the process by which cells divide to produce genetically identical daughter cells

A diploid ($2n$) cell can divide by mitosis to give rise to a population of genetically identical diploid ($2n$) cells

A haploid (n) cell can divide by mitosis to give rise to a population of genetically identical haploid (n) cells

Typical Plant Life Cycle

A haploid (n) spore divide by mitosis to produce a haploid (n) multicellular gametophyte

Haploid (n) cells of a mature gametophyte divide by mitosis to produce haploid (n) gametes

Gametes (n) fuse in fertilization to form a diploid ($2n$) zygote

The zygote ($2n$) divides by mitosis to produce a diploid ($2n$) multicellular sporophyte

Diploid ($2n$) cells of the mature sporophyte divide by meiosis to produce haploid (n) spores

By definition, gametophytes produce gametes and sporophytes produce spores

Typical Moss Life Cycle

Haploid (n) spores germinate and divide by mitosis to produce haploid (n) multicellular gametophytes, some of which are male gametophytes and some of which are female gametophytes

Haploid (n) cells of mature male gametophytes in structures called antheridia (singular – antheridium) divide by mitosis to produce haploid (n) male gametes (sperm), and haploid (n) cells of mature female gametophytes in structures called archegonia (singular – archegonium) divide by mitosis to produce haploid (n) female gametes (eggs)

Haploid (n) male gametes are transferred via rainwater or dew from antheridia of male gametophytes to archegonia of female gametophytes where a haploid (n) sperm cell fuses with a haploid (n) egg cell (fertilization) within an archegonium to form a diploid ($2n$) zygote

The zygote ($2n$) divides by mitosis within the archegonium to produce a diploid ($2n$) multicellular sporophyte that remains attached to the female gametophyte

Diploid ($2n$) cells of the mature sporophyte in a structure called a capsule (which is a sporangium) divide by meiosis to produce haploid (n) spores

Haploid (n) spores are released from the sporangium and fall to the ground where they germinate and divide by mitosis ……

Typical Moss Gametophytes

Many moss gametophytes have leafy stems that grow closely together and form dense mounds

Hence, the most obvious moss structures that we see growing on the ground or on tree trunks in moist areas are mats of leafy gametophyte stems

Moss gametophytes are green because they contain photosynthetic cells; therefore, moss gametophytes are autotrophic and make their own organic food molecules

Moss gametophytes absorb water (which contains dissolved minerals) directly from the moist environment, and the water moves from cell to cell by diffusion (remember, mosses are nonvascular – they do not contain xylem and phloem, the transport tissues of vascular plants)

Moss gametophytes do not have roots, but they do have structures called rhizoids, which anchor them to the substrate on which they are growing (rhizoids only anchor the stem; they do not appear to be involved in absorbing water or minerals)

Typical Moss Sporophytes

After fertilization, the diploid ($2n$) zygote (which is inside an archegonium on a female gametophyte) divides by mitosis to form a multicellular diploid ($2n$) sporophyte

A mature sporophyte is composed of three parts

A foot, which forms at the base of the archegonium and is involved with the absorption of water, minerals, and sugars from the gametophyte

A narrow stalk, the seta (plural – setae), which grows out of the archegonium and projects above the leafy gametophyte

An apical sporangium called the capsule, which contains diploid ($2n$) cells that undergo meiosis to form haploid (n) spores

Moss sporophytes are not green because they do not contain photosynthetic cells; therefore, moss sporophytes are heterotrophic and obtain their organic food molecules from the gametophyte

Why Mosses Grow in Moist Environments

Mosses are nonvascular and do not have roots; therefore, they must be in contact with a moist environment from which water can be absorbed directly into the cells of the gametophyte

Mosses produce motile sperm in antheridia on male gametophytes, and the sperm cells must get from there to egg cells located in archegonia on female gametophytes; therefore, a moist environment (usually in the form of raindrops or dew) is required for the transfer

Why Mosses Are Small

Mosses are nonvascular; therefore, the transfer of water and minerals from the environment to the interior of the gametophyte, the movement of water, minerals, and organic food molecules within the tissues of the gametophyte, and the movement of water containing waste products back to the environment must occur by diffusion, which is inefficient compared to transport via xylem and phloem

This lecture outline was prepared partly from *Biology*, by Campbell and Reece, 2002 (6th edition), and from *Botany – An Introduction to Plant Biology*, by Mauseth, 1998 (2nd edition), and may contain phrases or entire sentences taken verbatim from those sources.