

Seed Plants I - Gymnosperms

Characteristics of Gymnosperms

Eukaryotic

Multi-celled (with cell walls composed of cellulose)

Autotrophic

Do have xylem and phloem

Do produce seeds

Do not produce flowers or fruits

The Groups of Gymnosperms

Ginkgos – Ginkgo

Cycads – Cycas, Zamia, other genera

Gnetophytes – Welwitschia, Gnetum, Ephedra

Conifers – Abies (firs), Cedrus (cedar), Picea (spruce), Pinus (pine), Pseudotsuga (Douglas fir), Tsuga (hemlock), Araucaria (Norfolk Island pine; monkey puzzle tree), Metasequoia (dawn redwood), Sequoia (redwood), Sequoiadendron (giant sequoia), Taxodium (bald cypress), Chamaecyparis, Cupressus (cypress), Juniperus (juniper), Taxus (yew)

Pine Life Cycle

A mature pine tree, which is a diploid ($2n$) sporophyte, produces two kinds of cones, pollen cones (male) and ovulate cones (female)

Inside of microsporangia located on the scales of the pollen cones, diploid ($2n$) cells divide by meiosis to produce haploid (n) microspores

Haploid (n) microspores (immature pollen grains) develop by mitosis into haploid (n) male gametophytes (mature pollen grains), which contain a tube cell and two nonmotile sperm cells

Inside of megasporangia (which, with a surrounding cell layer called the integument, are known as ovules) located on the scales of the ovulate cones, a diploid ($2n$) cell known as a megaspore mother cell divides by meiosis to produce a haploid (n) megaspore

The haploid (n) megaspore develops by mitosis into a haploid (n) female gametophyte, which has two or three archegonia containing one egg each (note: the female gametophyte develops within the megasporangium in the ovule, which remains attached to the scale of the ovulate cone)

A pollen grain (male gametophyte) is transferred by wind from a pollen cone to an ovulate cone (pollination) where it comes into contact with an ovule

The pollen grain germinates and the tube cell produces a pollen tube, which grows through the tissues of the megasporangium to an archegonium of the female gametophyte

A haploid (n) sperm cell migrates through the pollen tube and fuses with a haploid (n) egg cell (fertilization) to produce a diploid ($2n$) zygote

The diploid ($2n$) zygote divides by mitosis within the female gametophyte to produce a diploid ($2n$) multicellular embryo (new immature sporophyte); old tissue of the female gametophyte serves as a food reserve

The ovule (still attached to the scale of the ovulate cone) matures into a seed, which contains an embryo (note: the seed is on the surface of the scale and is not inside of anything – hence, the term “naked” seeds)

The seed falls to the ground where it germinates and the diploid ($2n$) embryo develops into a diploid ($2n$) seedling, which develops into a mature diploid ($2n$) sporophyte (pine tree)

Typical Gymnosperm Gametophytes

Gymnosperm gametophytes are very small; the male gametophyte is a mature pollen grain, which contains only three cells – a tube cell and two sperm cells; the female gametophyte is multicellular, but it develops within the megasporangium in the ovule

Gymnosperm gametophytes are not green; therefore, they are not autotrophic

Gymnosperm gametophytes are not free-living structures; mature male gametophytes are nothing more than mature pollen grains, and mature female gametophytes are never free of the interior of the megasporangium in the ovule

Typical Gymnosperm Sporophytes

After fertilization, the diploid ($2n$) zygote divides by mitosis to form a multicellular diploid ($2n$) embryo (new young sporophyte) inside the ovule

The gymnosperm embryo develops into a seedling and eventually into a mature sporophyte

A mature sporophyte is composed of three parts: roots, stems, and leaves

Mature leaves of gymnosperm sporophytes are green because they contain photosynthetic cells; therefore, gymnosperm sporophytes are autotrophic

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.