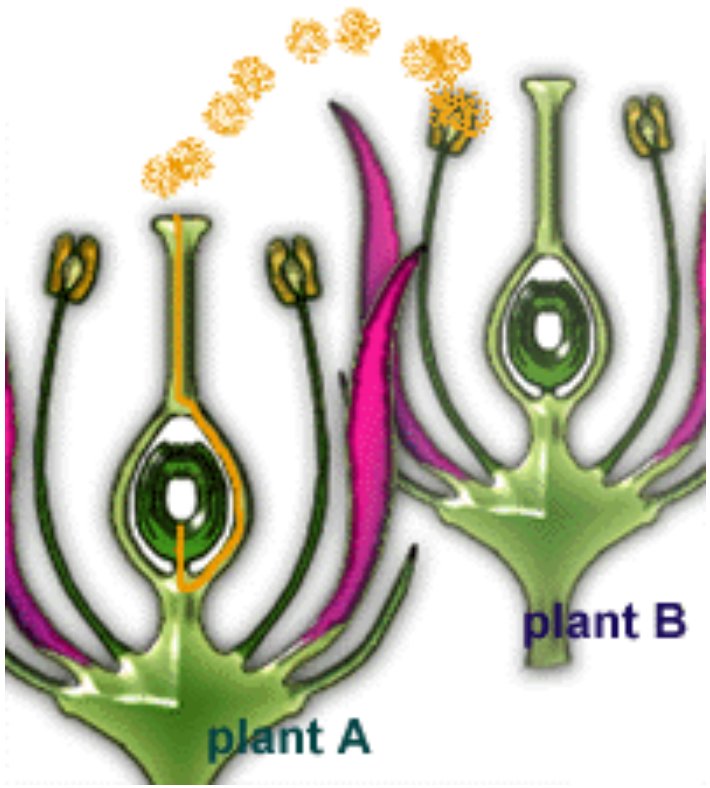
POLLINATION

What is pollination?

- **Pollination**: The transfer of pollen from the male **anther** to the female **stigma**



Why is pollination important?

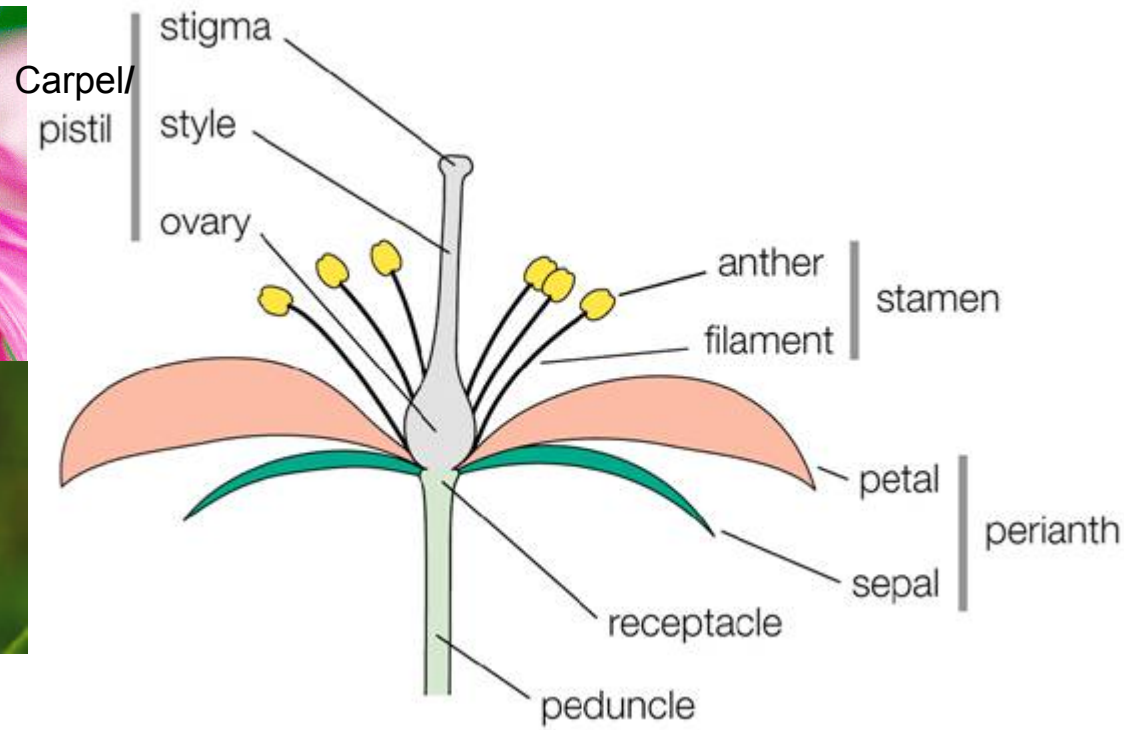
- **Sexual reproduction** is important for evolution:
- **Sexual reproduction** produces **variable offspring,** creating diversity and variation among populations (shuffling of genes)
- You need variation for Natural Selection to occur
- Sexual reproduction is advantageous to an organism only if it happens with someone other than itself!
- Outbreeding = good! (inbreeding = bad…)

Sexual reproduction

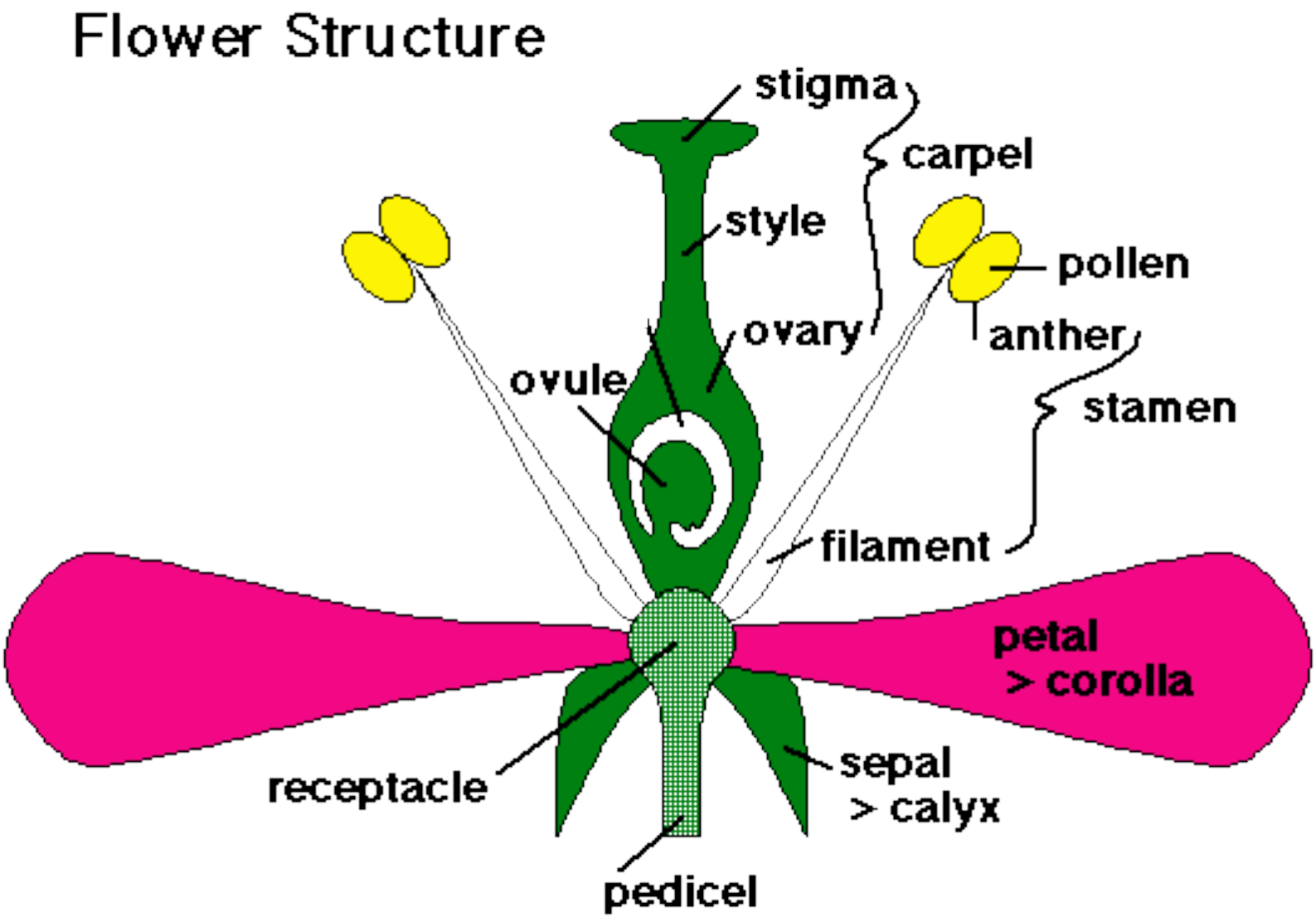
- In animals: It's easy because you have separate male and female individuals.
- In flowering plants: Not so easy, because most flowers have <u>both</u> male and female parts in them, called **perfect flowers**.
- So flowering plants have evolved special ways to insure outbreeding/outcrossing – and to prevent inbreeding.

Function of flower

- To attract pollinators with colorful petals, scent, nectar and pollen

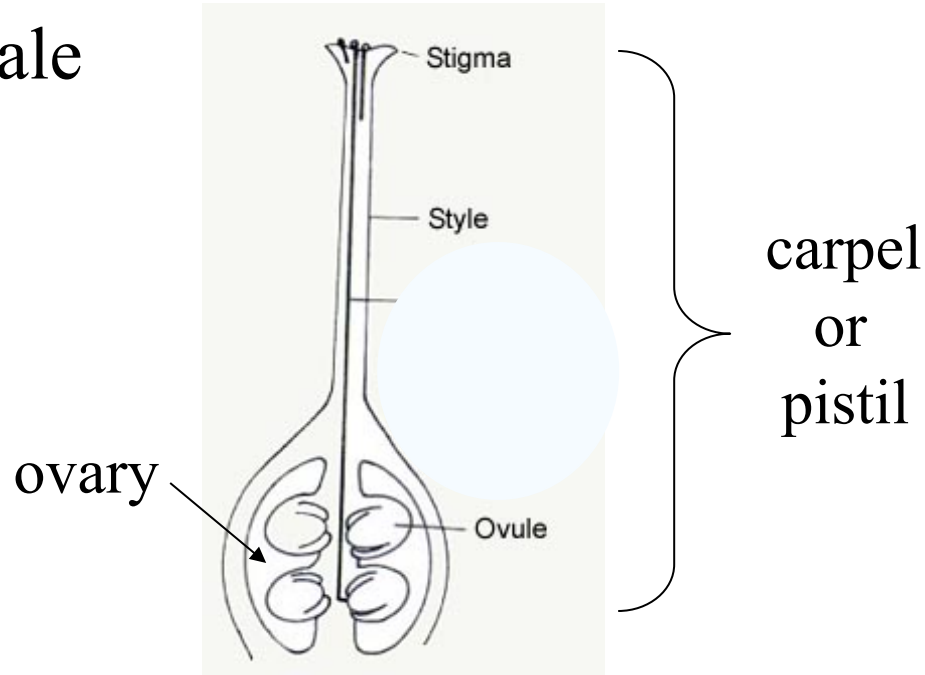


Overview of floral organs



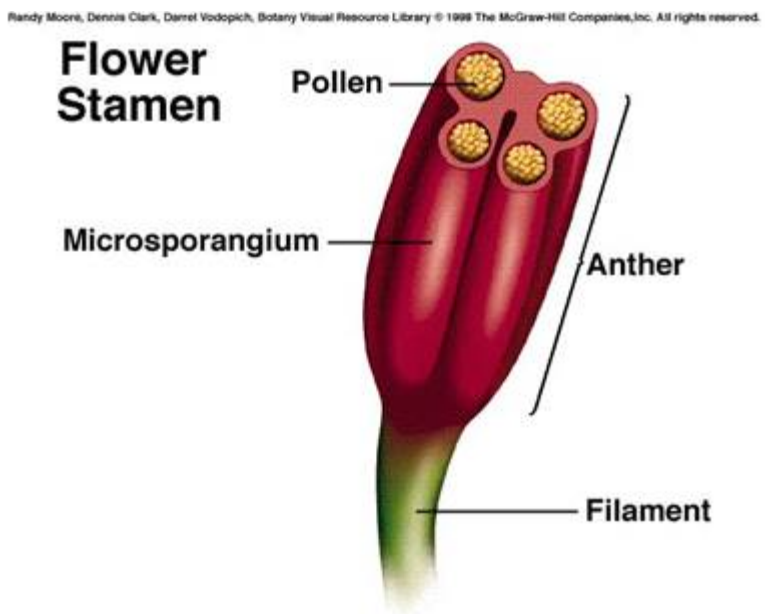
Reproductive floral organs: female

- **Carpel** or **pistil** – female reproductive organs; contains:
- **Stigma –** is where pollen sticks to
- **Style** – is the long tube that connects stigma to ovary
- **Ovary** – enlarged structure at the base of carpel/pistil where the ovules are located; it will become the fruit.
- **Ovules** – contains female gametophyte, becomes the seed
- Plants have style!



Reproductive floral organs: male

- **Stamen** – male floral organ, consists of:
- **Anther** – part of the stamen that produces pollen
- **Filament** – stalk-like structure that holds anther
- **Pollen** – immature male gametophyte



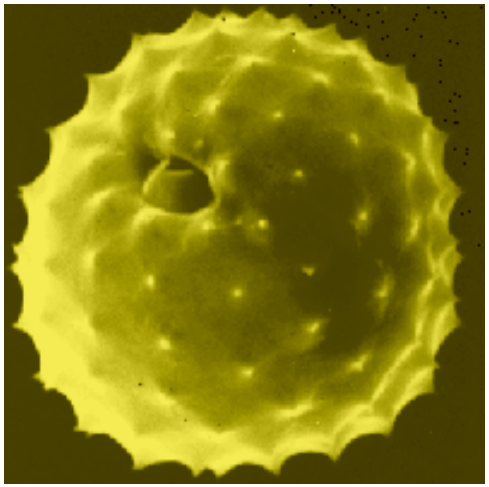
Non-reproductive floral organs

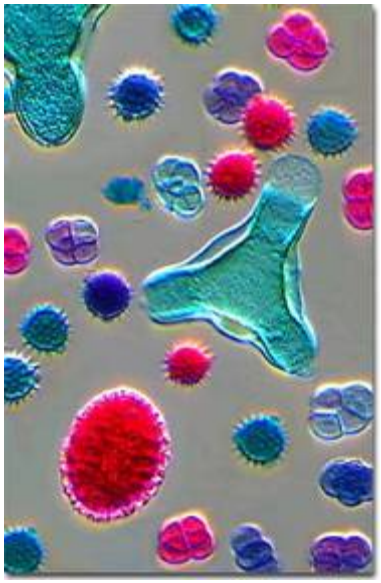
- **Petals** – whorl of flower organs that are often brightly colored to attract pollinators
- **Corolla** – whorl of petals in a flower

- **Sepals** – whorl of leaf-like organs outside the corolla; help protect the unopened flower bud.
- **Calyx** – whorl of sepals in a flower
- **Tepals** – when sepals and petals look the same

Pollination and Fertilization

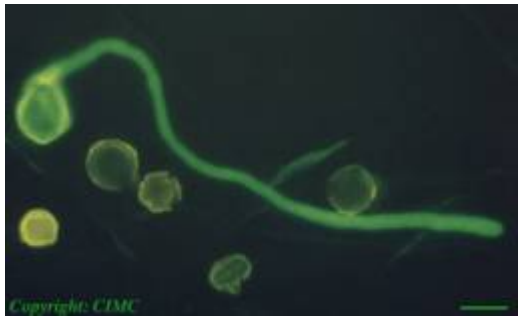
- Pollen contains TWO nuclei: a **sperm** nucleus and **tube** nucleus
- Sperm nucleus is protected in gametophyte tissue (pollen can travel in the air)

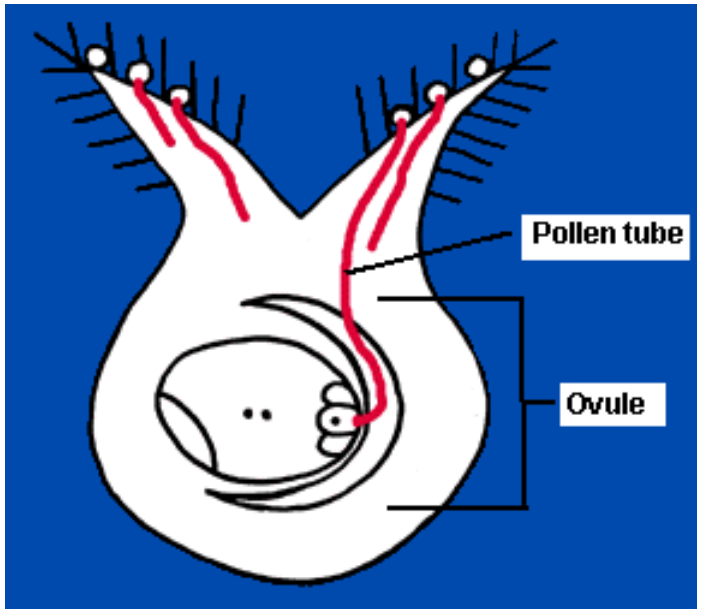




Pollination and Fertilization

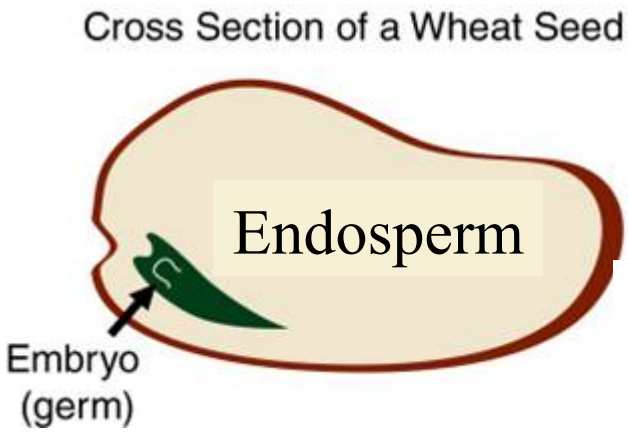
- For pollen sperm to successfully fertilize the egg, there must be **pollination**: a method to get the pollen from the male anther to the stigma.
- Pollen sticks to the stigma, starts growing a pollen tube
- **Fertilization** begins when tube begins to grow toward the egg

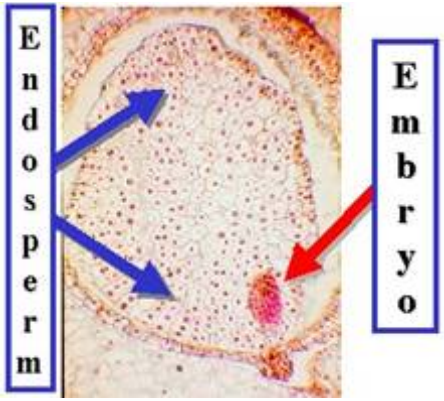




Double Fertilization

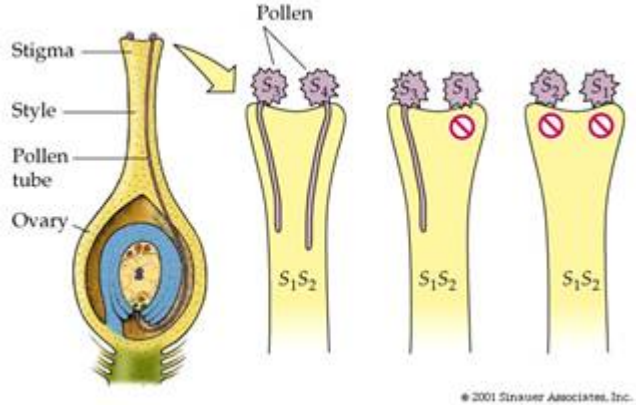
- **Double fertilization** occurs: One sperm nucleus (1n) fertilizes the egg, producing a **zygote** (2n) → which becomes the plant **embryo** inside the seed
- Another sperm nucleus fuses with the polar nuclei, resulting in a triploid **endosperm** (3n)
- Endosperm is a source of food for the young embryo.





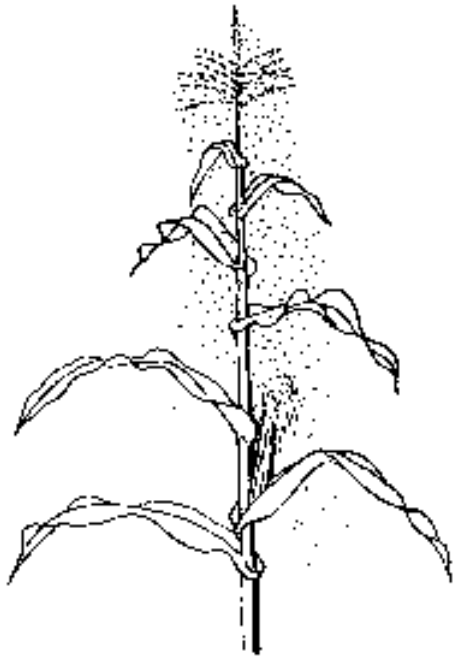
Strategies to avoid self-pollination

- Perfect flowers have both male and female organs, so plants have strategies to avoid self-pollination:
- 1. **Timing** – male and female structures mature at different times
- 2. **Morphological** – structure of male and female organs prevents self-pollination (imperfect flower)
- 3. **Biochemical** – chemical on surface of pollen and stigma/style that prevent pollen tube germination on the same flower (incompatible)



How do plants get pollen from one plant to another?

- Because plants are rooted in the ground, they must use different strategies:
- **WIND POLLINATION**:
- Gymnosperms and some flowering plants (grasses, trees) use wind pollination.
- Flowers are small, grouped together
- Not a very efficient method (too chancy and wasteful)



ANIMALS

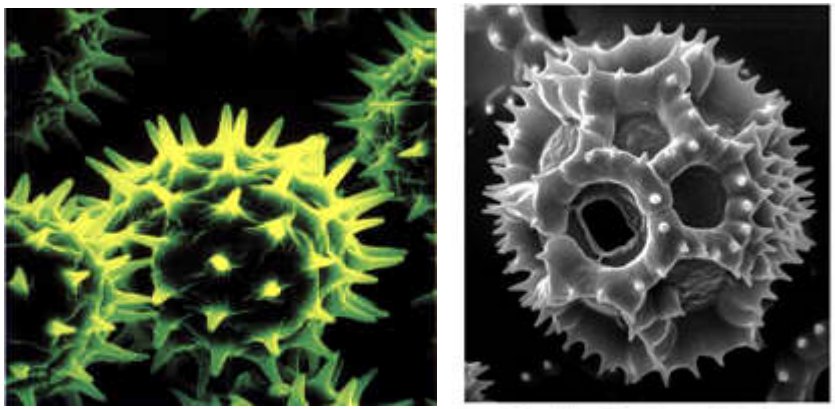
- Many flowering plants rely on animals for cross-pollination:
- **Insects** – bees, wasps, flies, butterflies, moths
- **Birds** – hummingbirds, honey creepers
- **Mammals** – bats, mice, monkeys
- Even some reptiles and amphibians!

Coevolution

- **Coevolution** – interactions between two different species as selective forces on each other, resulting in adaptations that increase their interdependency.
- Animal-flowering plant interaction is a classic example of coevolution:
- 1. Plants evolve elaborate methods to attract animal pollinators
- 2. Animals evolved specialized body parts and behaviors that aid plant pollination

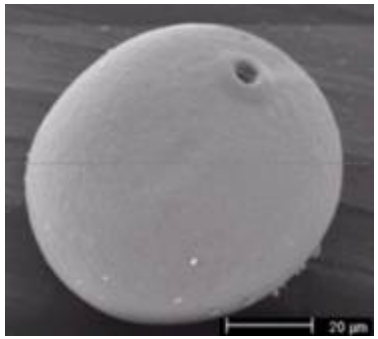
A word about pollen…

- The shape and form of pollen is related to its method of pollination…
- Insect-pollinated species have sticky of barbed pollen grains



Dandelion (Taraxicum officinale)
http://usda-apmru.tamu.edu/pollen/graphics/Taraxicum_officinale.htm

- Wind-pollinated species is lightweight, small and smooth (corn pollen)



Palynology: the study of pollen

- Palynology is useful in many fields:
- **Petroleum geology** – fossil pollen can determine if a field will have oil-rich deposits
- **Archeology** – studying ancient pollen samples, archeologists can determine agricultural practices, diet, etc.
- **Anthropology** – uses of pollen in rituals
- **Criminology** – to determine the whereabouts of an individual, examine pollen clinging to clothes
- **Aerobiology** – to determine what plants cause hay fever and allergic reactions – in landscaping

Animal pollinators: Bees

- **Bees** – are the most important group of flower pollinators
- They live on the nectar and feed larvae, also eat the pollen.
- Bees are guided by sight and smell
- See **yellow** and **blue** colors, also ultraviolet light (not red)
- Flowers have "honey guides" and bee landing platforms..

Butterflies and moths

- Also guided by sight and smell
- Butterflies can see **red** and **orange** flowers
- Usually shaped as a long tube because of insect's proboscis – to get nectar
- Moth-pollinated flowers are usually white or pale, with sweet, strong odor – for night pollination.

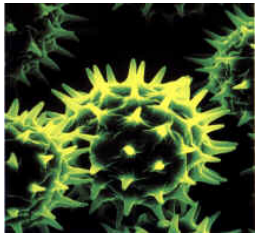
Flies and beetles

- Flies like flowers that smell like dung or rotten meat.
- Lay their eggs there, but larvae die due to lack of food

- Beetles pollinate flowers that are dull in color, but have very strong odor

Birds

- Birds have a good sense of color, they like yellow or **red** flowers…
- But birds do not have a good sense of smell, so bird-pollinated flowers usually have little odor.
- Flowers provide fluid nectar in greater quantities than insects
- Hummingbird-pollinated flowers usually have long, tubular corolla
- Pollen is large and sticky



Mammals: bats and mice

- Bats pollinate at night, so flowers are white

- Mouse-pollinated flowers are usually inconspicuous, they open at night

Why do animals pollinate plants?

- They get a REWARD: food! In exchange for moving their pollen to another flower
- **Nectar** – a sugary solution produced in special flower glands called nectaries
- Nectar concentration matches energy requirements of the pollinator: bird- and bee-pollinated flowers have different sugar conc.
- **Pollen** – is high in protein, some bees and beetles eat it.
- Flowers can produce two kinds of pollen: a normal and a sterile, but tasty, kind, for the insect.

Getting the pollinator's attention

- Plants advertise their pollen and nectar rewards with
- Colors – bees see **blue**, **yellow**, UV; while birds see **red**. Bats don't see well, so flowers are white.
- Nectar or honey guides –
  a visual guide for pollinator
  to locate the reward (pansy flower)
- Aromas – for insects, nectar.
  Can also be carrion or dung smell

Plant Mimicry

- Some plants take advantage of the sex drive of certain insects…
- Certain orchids look like female wasps, and even smell like them!
- Males try to mate with them, and in the process they pollinate the plant
- The orchid gets pollinated, but the male wasp only gets frustrated!

Questions

- What causes “hay fever”? _____
- What carries pollen released by grasses (corn)? _____
- A flower with both male/female structures is a ___flower
- What increases genetic variability in a population?____
- What color flowers do birds pollinate? Bees? Moths?
- Why are bird-pollinated flowers usually odorless?_____
- What time of the day do bats pollinate?_____
- What two rewards do insects get from flowers?_____
- Flies and butterflies reach the nectar using a long _____
- Flies pollinate flowers that smell like rotting _____
- Why do some orchids look and smell like wasps?_____