

Secret Sex Lives of Plants

And why it even matters!

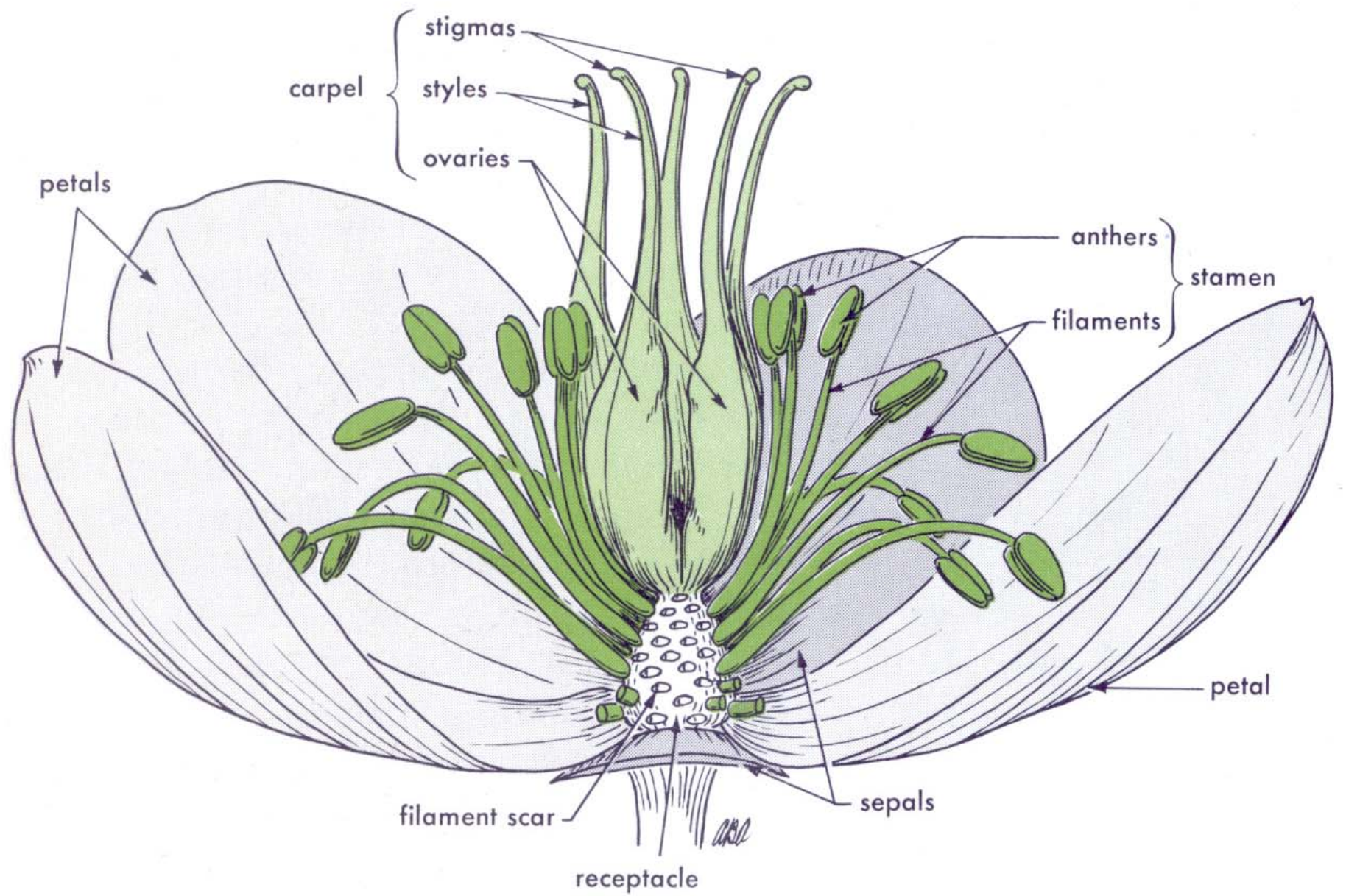
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Let's Start With the Parts

- Plants have female plant parts (pistil).
- Plants have male plant parts (stamen).
- To produce seed (fruit), a plant species must have male and female plant parts.

Let's Start With the Parts

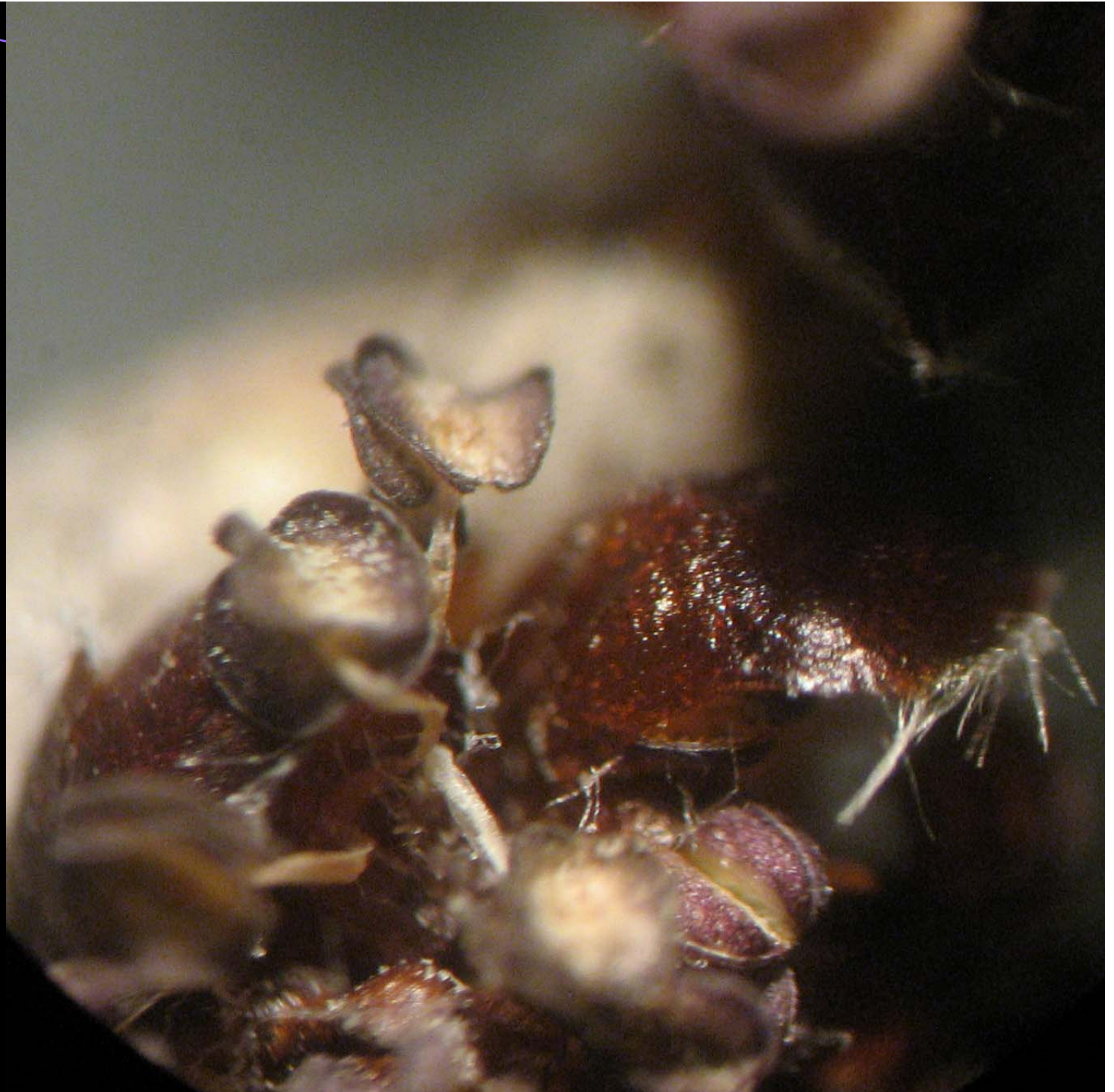
- Some plants will have all the parts (stamen and pistil) together in one flower, often called a perfect flower.
- Some plants have them on separate structures on the same plant (monoecious).
- Some have them on different plants (dioecious).



Okay, what are some examples?

- Perfect flowers
 - Peas
 - Tomatoes
 - Zinnias
 - Sunflowers
 - Elms
 - Maples

Flowers of
Siberian Elm,
the capsules
and opened
“things” are
the anthers
that contained
the pollen
grains. The
stigmas are
deeper down
in the flower.



Flowers of Silver Maple. The fuzzy sticks that are pink and white are the stigma of the female flower. Pollen will land on these to fertilize the egg and produce a seed.



Okay, what are some examples?

- Monoecious
 - Corn



Eastern
Gama-grass –
the left picture
shows the
anthers on the
male flower.
The right
photo shows
the stigmas of
the female
flowers.




Okay, what are some examples?

- Monoecious

- Corn
- Oaks
- Walnuts
- Pecans/hickories
- Pines
- Squash, pumpkins and melons


Okay, what are some examples?

- Dioecious
 - Cedar trees



Left - Flowers of a male Eastern Red Cedar. The brown tips that are separating are the pollen containing anthers.

This image shows several male flowers of an Eastern Red Cedar. The flowers are small, yellowish-brown, and clustered along a green stem. A white circle highlights one flower, showing its internal structure where the pollen-containing anthers are located. A purple arrow points from the text to the highlighted flower.



Right - Flower of a female Eastern Red Cedar. The flower is the creamy colored structure in the middle of the photo. The stigma is down inside the structure.

This image shows a single female flower of an Eastern Red Cedar. The flower is a creamy, yellowish color and is surrounded by green, scale-like bracts. A white circle highlights the flower, showing its internal structure where the stigma is located.

Okay, what are some examples?

- Dioecious
 - Cedar trees
 - Holly
 - Poison ivy
 - Ash/Cottonwood
 - Osage Orange (hedge)
 - Buffalograss

A photograph of a dense field of tall, green grass. The grass blades are long and thin, and many of the stems are topped with small, light-colored, feathery seed heads or flowers. The overall appearance is that of a healthy, growing lawn or meadow.

Flowers of Buffalograss often assumed by homeowners to be seed heads. In reality they are the male flowers and all they do is shed pollen.



Female flowers of Buffalograss. The little pale knots in the center of the picture is where the seed develops. It is very close to ground level.

So What?!

- Seedless trees
- Lack of holly berries
- Poor sweet corn production
- Seedless watermelons?
 - No, but we'll get to that!

Dioecious crop trivia

- Date Palms
 - Without adequate male plants, few or no dates will be produced.
- Hops
 - The female flower is valued for beer making. Seeds are not needed so hop orchards are all female plants.
- Hemp
 - Only female plants produce THC, absence of males elevates THC content.

Dioecious crop trivia

- Asparagus – male plants out yield female plants by about 25%. But female plants have a larger shoot (stalk) and a more desirable appearance. Plants of both sexes often carry rudimentary organs of the opposite sex which usually fail to develop – BUT male plants will occasionally develop seed bearing fruits.

Pollination

- For a plant to produce seed, the female flowers must be successfully pollinated by the male flowers.
- A pollen grain lands on the stigma, the pollen grain “germinates” and the pollen tube grows through the style and enters the ovary where the genetic material is released and fuses, hopefully, with the egg cell.

But how does the pollen arrive?

- In perfect flowers, the pollen may be shed within millimeters of the stigma.



But how does the pollen arrive?

- In perfect flowers, the pollen may be shed within millimeters of the stigma.
- In many monoecious and dioecious plants, wind is the principal spreader of pollen.
- In some species, even with perfect flowers, insects are needed, i.e. honeybees.

But how does the pollen arrive?

- Honeybees are strongly associated with pollination but many other species accomplish this also:
 - Other bees
 - Moths
 - Flies
 - Bats
 - Birds

Self pollination or cross pollination?

- Some species are self fertile.
- Some species are self sterile.
- Even in self fertile species, cross pollination can be a benefit in the form of improved production (more seeds/fruits) or improvement in the adaptability of the species.

Self sterile or self incompatible?

Timing – nonsynchronous development of the pistillate and staminate organs.



Self sterile or self incompatible?

- Timing
- Physiological barriers (inc)
- Genetic causes
 - Pollen Germination Inhibition (inc)
 - Pollen Tube Inhibition (inc)
 - Cytoplasmic and genetic male sterility (ster)

So what? Why do I care?

- Do I plant one fruit tree, or two?
 - Most fruit production cross pollination requirements are because of poor pollen production.
- Why aren't my zucchini producing zucchini even though they are covered with blooms?



← Female flower
– note the small
fruit structure
already growing
between the
blossom and the
vine.



Male flower →
Note that the connection
between the blossom and
the vine is just a thin
stem.

So what? Why do I care?

- Do I plant one fruit tree, or two?
 - Most fruit production cross pollination requirements are because of poor pollen production.
- Why aren't my zucchini producing zucchini even though they are covered with blooms?
- Why can't I save seed from hybrid varieties?

Genetics

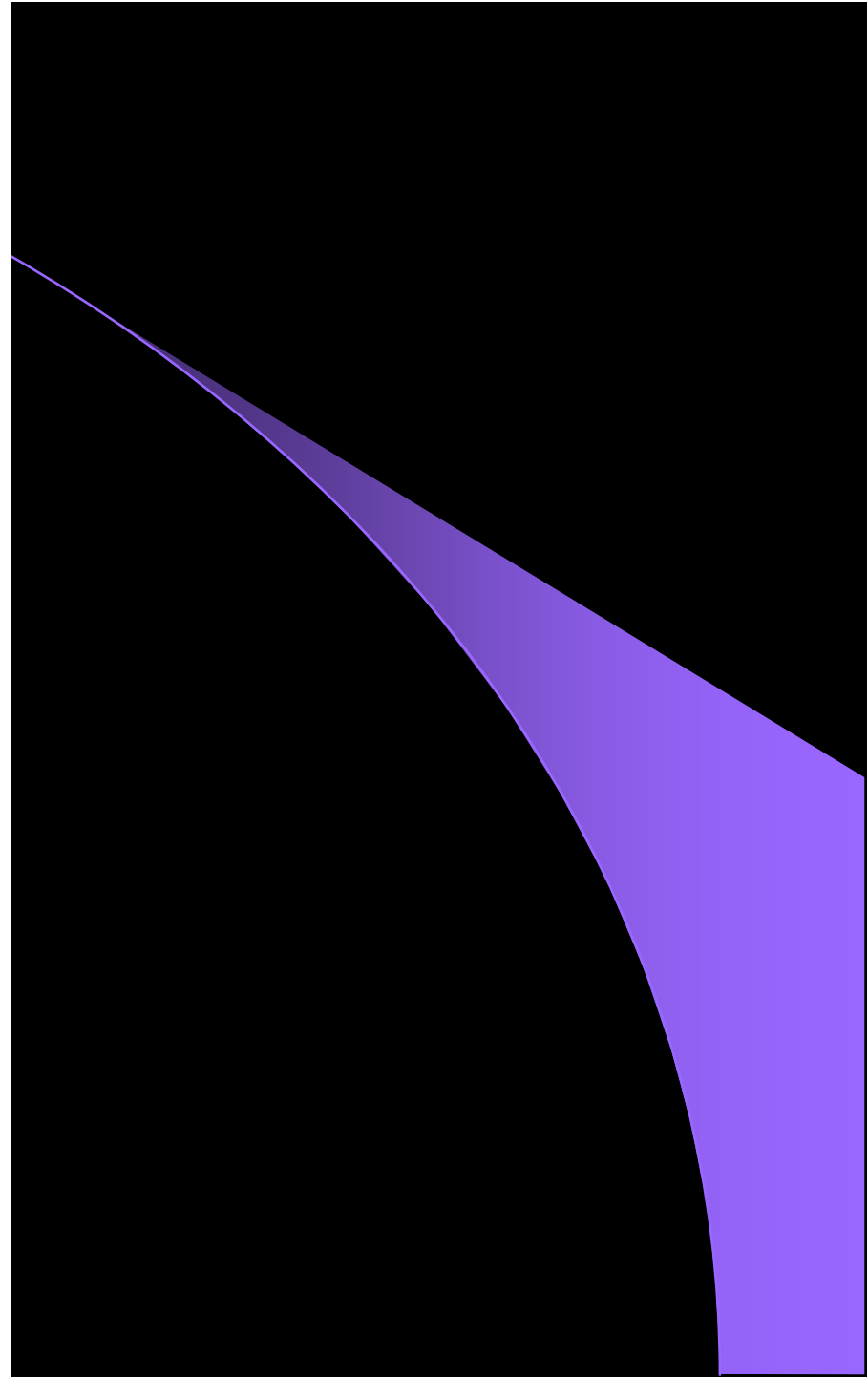
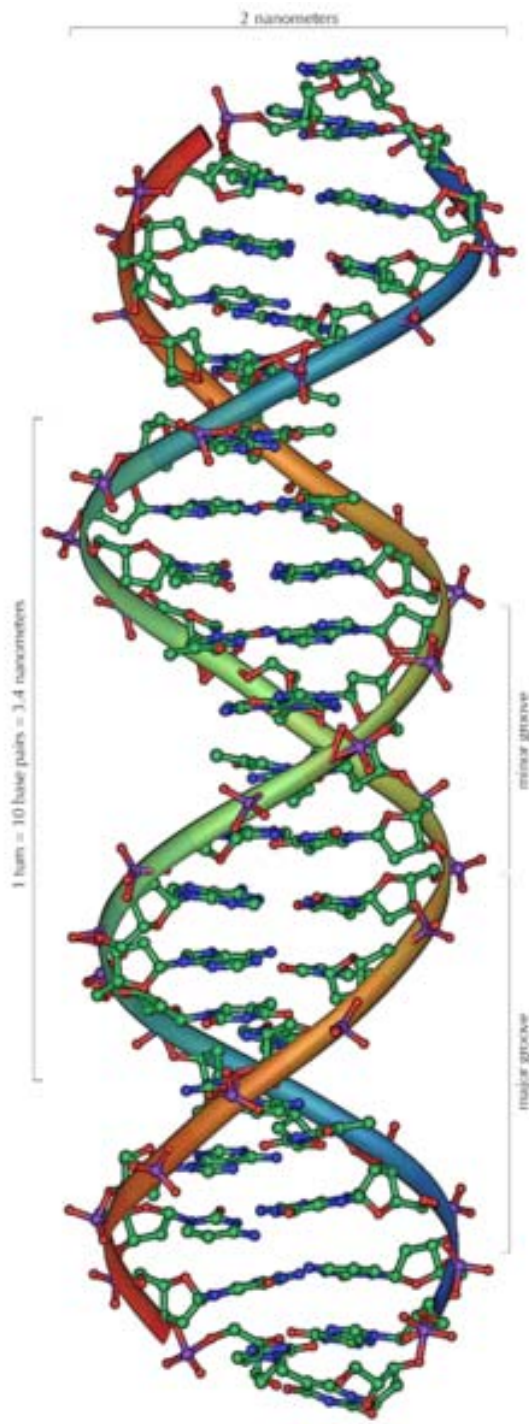
- An individual organism is the result of combined genetic material, one half from each parent.
- Genetics establish the parameters (limits), environment determines where within those limits any one individual is.

Genetics

- Genes are located in the chromosomes in the nucleus of the cell. These are 50% from the female parent and 50% from the male parent. (Mendelian or molecular genetics)
- There can also be cytoplasmic influences from bits of genetic material outside the nucleus.

Genetic terms

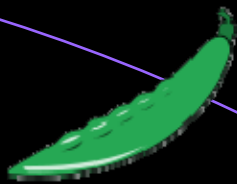
- Gene – unit of inheritance located at fixed loci (points) on a chromosome
- Alleles – one of a pair of forms of a gene
- Homozygous – having like alleles (yy or YY) at the same loci
- Heterozygous – having unlike alleles at the same loci (Yy)



Genetics

- We are going to stick with very basic, simple genetics. In reality most plant traits are complex gene combinations.
- Some traits are controlled by one pair of genes, some traits by many pairs of genes.
- Genes are generally dominant or recessive.
- The dreaded Punnett square

y y



Y

Yy

Yy



y

yy

yy



	Y	y
Y	YY	Yy
y	Yy	yy

Genetic terms

- Haploid, Diploid, Triploid, Tetraploid – refers to the number of chromosomes of each kind, 1, 2, 3 or 4.
- Most organisms are diploid and the egg/pollen each carry one set of chromosomes. The number of chromosomes varies widely.
- Humans – 46, barley – 14, bean – 22, corn – 20, pea – 14, potato – 48, wheat 42

So What?

- Diploid and Tetraploid are generally fertile, triploids are usually sterile.
- Seedless watermelons are triploids!
- How do they do that????

Chemicals!!!!

- Colchicine causes a doubling of chromosomes. Watermelon usually has 2 sets of chromosomes and after treatment it has 4 (tetraploid). Each pollen grain or egg thus has twice the normal chromosomes or 2 instead of 1. This is crossed with a standard watermelon variety, $2n + 1n = 3n$. Seeds are small and undeveloped and sterile.

My bell peppers cross pollinated with my jalapenos

- And now they are hot!
- NOT!!!!!!!!!!
- Peppers (and tomatoes) are perfect flowers and highly self fertilized. (But out crossing does occur.)
- The genes of the parents determine how a plant grows and what the fruit will be like.

My bell peppers cross pollinated with my jalapenos

- If the seed is saved from the bell peppers and grown out, some of the peppers probably would be hot (heat is a dominant gene).
- But the pollen that makes the seed in the pepper will not influence the flavor or heat of the fruit. The seeds might be hot if you ate them.

My bell peppers cross pollinated with my jalapenos

- If in fact the fruit is hot, then the problem is stemming from lack of isolation in the seed production field last year!

Sweet Corn is really touchy

- Sweet Corn is sweet because the genes allow more sugar (instead of starch) to develop in the endosperm (kernel) – 5% up to 20% sugar.
- There are three different genes that control sweetness: Su, Sh2, Se (standard, supersweet, sugary enhanced).



Su



Sh₂



Se

Sweet Corn is really touchy

- All of these genes are recessive.
- The endosperm of the seed develops from genes from both parents.
- If any sweet corn variety is cross pollinated with field corn the carbohydrates deposited in the seed will be starchy not sugary
- Corn is monoecious and is widely cross pollinated

Sweet Corn is really touchy

- The se and su alleles are on the same gene and do not need to be isolated from each other.
- But, sh2 is on a different gene and requires isolation from all other varieties of corn to avoid cross pollination.
- 100 to 400 feet or in time.

But wait, there's more

- Now a 4th type of sweet corn
- SY – synergistic
- 75% of the kernels are SE and 25% are sh2
- su, se and sy can be grown in proximity to each other (but separated from field or popcorn).
- sh2 needs to be separated from any other corn.

Other cross pollination myths

- My cucumbers/watermelon/muskmelon cross pollinated with my watermelon/muskmelon/cucumbers and now they taste funny.
- All three of the above mentioned (and include squash in the mix) are from different genera and CAN NOT cross pollinate. Different chromosome number.

Other cross pollination myths

- Tomatoes, potatoes and peppers are all in the Solanaceae family and have the same number of chromosomes, can they cross pollinate?
- No. They are strongly self fertile AND many attempts over the years to cross these different genera have failed.

But why can't I save seed from the hybrids?

- Remember heterozygous? Dominant and recessive alleles at the same loci.
- When two homozygous individuals are crossed (pure lines), you wind up with a hybrid that is highly heterozygous.
- In many plants this creates what is known as hybrid vigor or heterosis.

But why can't I save seed from the hybrids?

- But when these hybrids (F_1) are self pollinated, the resulting generation (F_2) starts to differentiate with all sorts of possible combinations. In general roughly 50% of the (F_2) offspring would be expected to be “similar” to the (F_1) “parent”. One of the basic concepts of plant breeding and deriving new cultivars.

	Y	y
Y	YY	Yy
y	Yy	yy

And finally

- What drives plant growth and “actions”?
- The overwhelming instinct/desire to see that its genes are around for another generation or next year.

Turf grasses

- Cool Season and Warm Season
- Vegetative growth vs reproductive growth
- Cool season starts growing earlier and heads out in May, then growth slows through summer.
- Warm season starts later and grows strong through the summer.

Annual Plants

- The only way that an annual plant can get its genes to next year is to produce seed (in the temperate climates – that is.)
- It has to flower and set seed. It will continue to bloom until it has produced seed and sometimes even beyond that.
- This will dictate how it reacts to the management we expose it to, i.e. deadheading, constant mowing, etc.

Perennial Plants

- They can produce seed for next year, OR they can keep themselves around and try to produce seed next year.
- Under periods of stress, (heat, moisture) many perennials will drop all seed (nuts, fruits, etc.)
- Others won't bloom until a certain stress or age factor trigger it to bloom – century plant.

Questions?

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