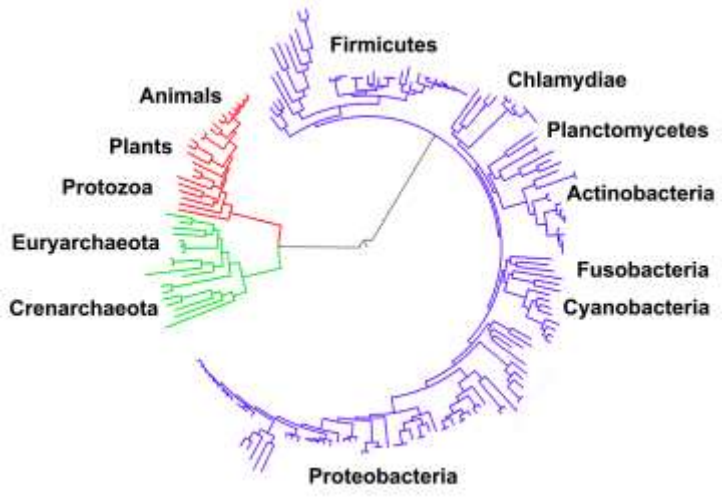
Plant Systematics and Plant/Pollinator Interactions

Jacob Landis



Why study plants

- Important for food



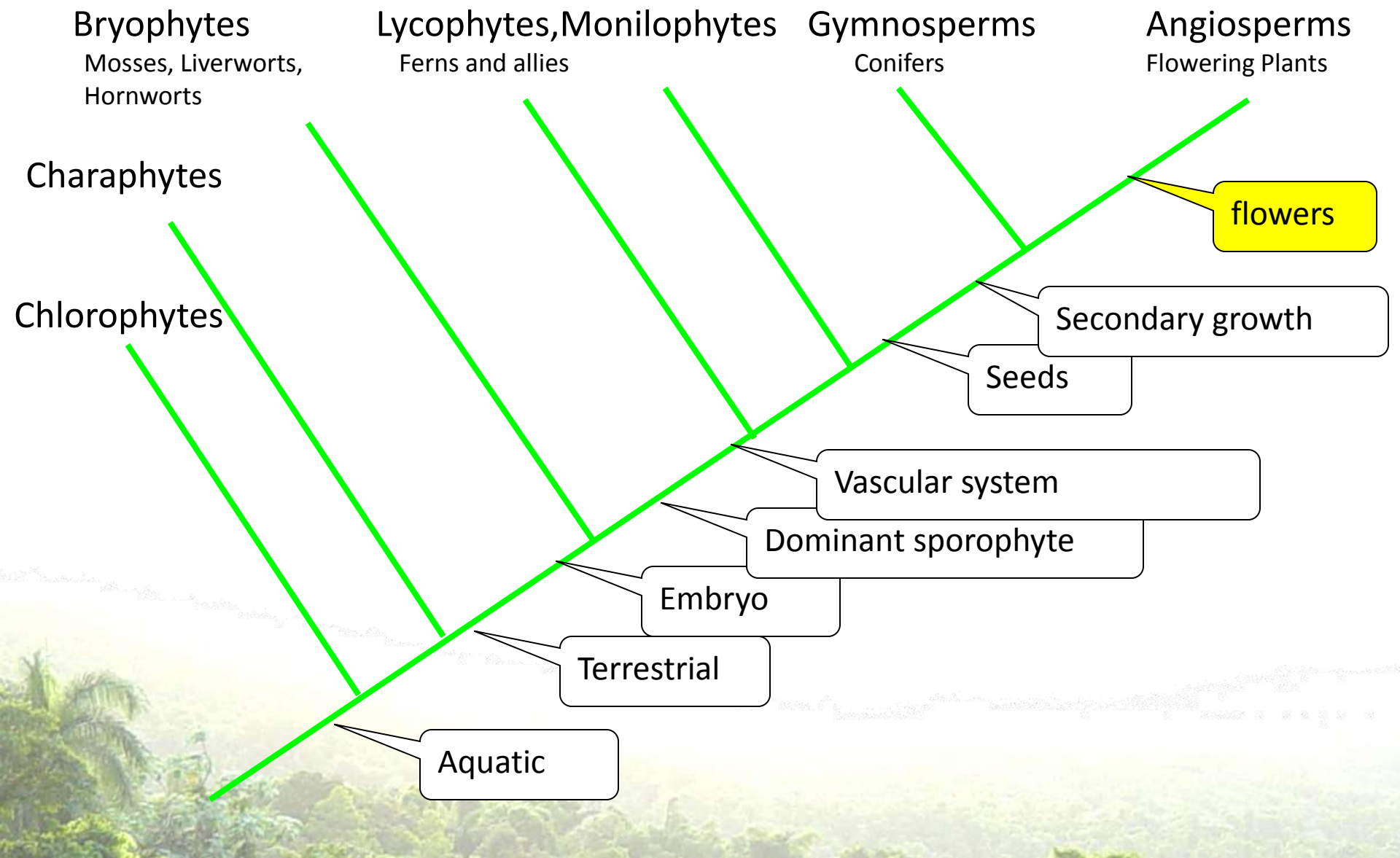
- Clothing



- Drugs



BASIC PHYLOGENY OF PLANTS



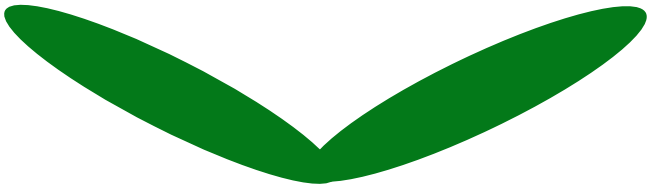
Flower Diversity

Flower Structure

Whorl name/number

Function

1



1. Sepals

1. Protection

Flower Structure

Whorl name/number

Function

2. Petals

2. Pollinator attraction

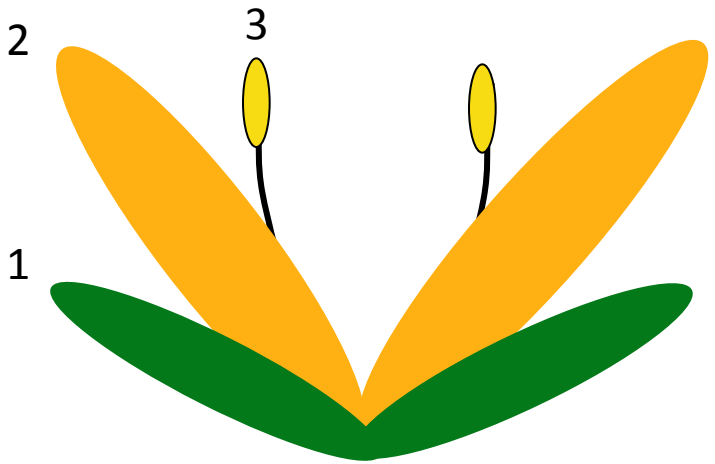
1. Sepals

1. Protection

Flower Structure

Whorl name/number

Function



3. Stamens

2. Petals

1. Sepals

3. Male gametes

2. Pollinator attraction

1. Protection

Flower Structure

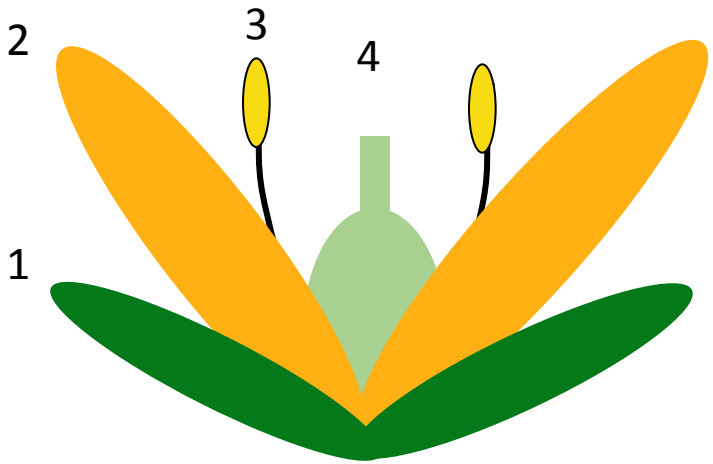
Whorl name/number

4. Carpels

3. Stamens

2. Petals

1. Sepals



Function

4. Female gametes

3. Male gametes

2. Pollinator attraction

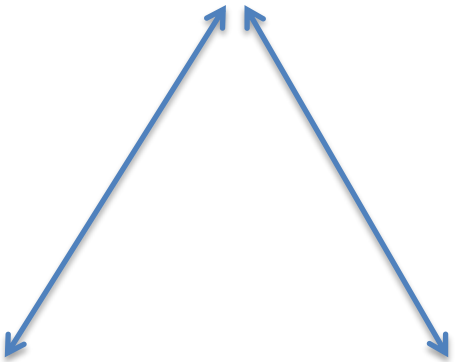
1. Protection

Research options

- Plant systematics → relationships among plants
- Flower Evo-Devo → how flowers develop, within or between species
- Plant/pollinator interactions → why does the flower look the way it does to attract its pollinator, and how did it get that way

Goal

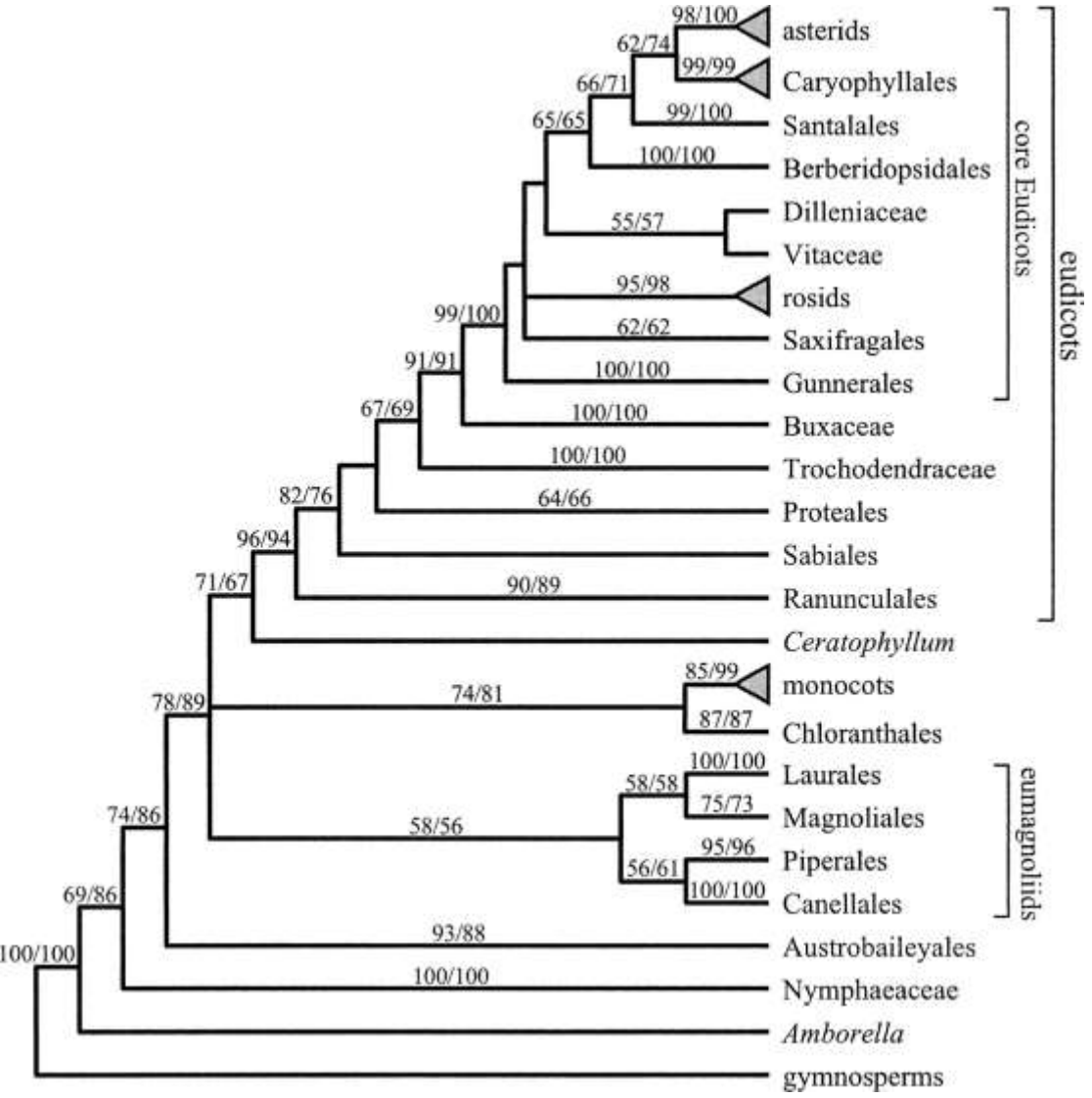
Adaptation



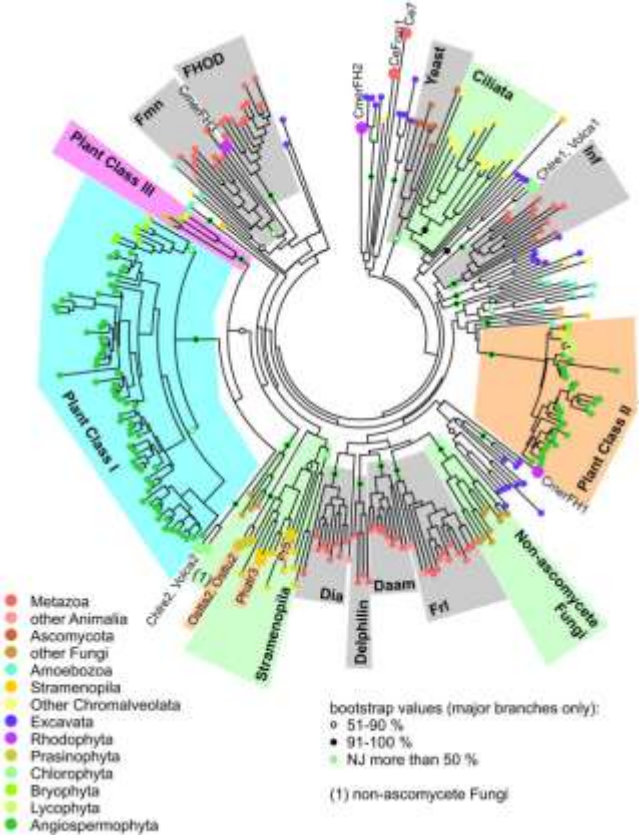
Genetics ⟷ Phenotype

- Overarching goal is to link genetic changes to observable adaptations (specific pollinators)

Phylogenetics



- Shows relationships between organisms
- Important in understanding why plants are the way they are



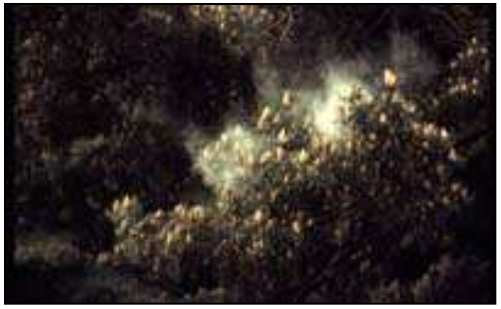
Phylogenetics continued

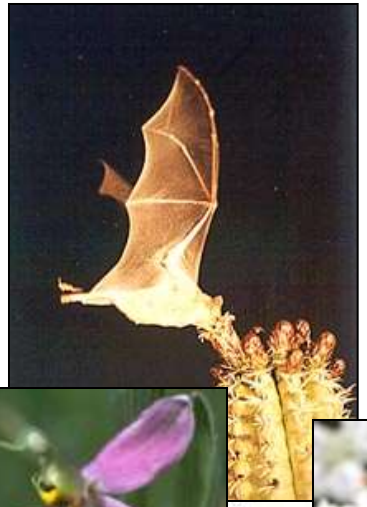
- Conducted with either morphological or molecular data
  - historically morphology
  - predominately molecular now

- You will get hands on practice with both methods
  - compare which method is easy, more repeatable

POLLINATION MECHANISMS

- **Abiotic Pollination**
  - Wind (anemophily)
  - Water (hydrophily)
- **Biotic Pollination**
  - Invertebrate
  - Vertebrate







FLORAL ADAPTATIONS FOR POLLINATION

- **Rewards**
  - Pollen
  - Nectar
  - Oil and other substances
  - Protection
  - Breeding area
  - Sexual attraction (pheromones)
- **Floral Cues**
  - Color
  - Shape
  - Size
  - Scent
- **Efficiency**
  - Shape
  - Position
  - Distance
  - Pollen-stigma

TABLE 4.1 **Floral pollination syndromes.**

	Floral characteristics				
Pollinator	**Color**	**Scent**	**Time of flowering**	**Corolla**	**Reward**
Bee	Blue, yellow, purple	Fresh, strong	Day	Bilateral landing platform	Nectar and/or pollen
Butterfly	Bright; often red	Fresh, weak	Day	Landing platform; sometimes nectar spurs	Nectar only
Moth	White or pale	Sweet, strong	Night or dusk	Dissected; sometimes nectar spurs	Nectar only
Fly (reward)	Light	Faint	Day	Radial, shallow	Nectar and/or pollen
Fly (carrion)	Brownish, purplish	Rotten, strong	Day or night	Enclosed or open	None
Beetle	Often green or white	Various, strong	Day or night	Enclosed or open	Nectar and/or pollen
Bird	Bright; often red	None	Day	Tubular or pendant; ovary often inferior	Nectar only
Bat	Whitish	Musky, strong	Night	Showy flower or inflorescence	Nectar and/or pollen
Nonflying mammals	Dull-colored	Unscented to variously strong	Night	Robust, exserted styles and stamens	Copious nectar and/or pollen

BEE POLLINATION SYNDROME

- Two types:
  - Showy, **open, bowl-shaped**
  - Showy, **complicated, zygomorphic** (specialized)

- All be flowers tend to be **yellow, blue, or purple**
- UV nectar guides
- Sweetly scented
- **Nectar and/or pollen**

BUTTERFLY POLLINATION SYNDROME

- Large and showy flowers with **landing platform**
- Or large clumps of smaller flowers
- Bright – **red, pink or lavender**
- **Long, narrow tubular flowers**
- Fresh, weak scent
- **Nectar only**





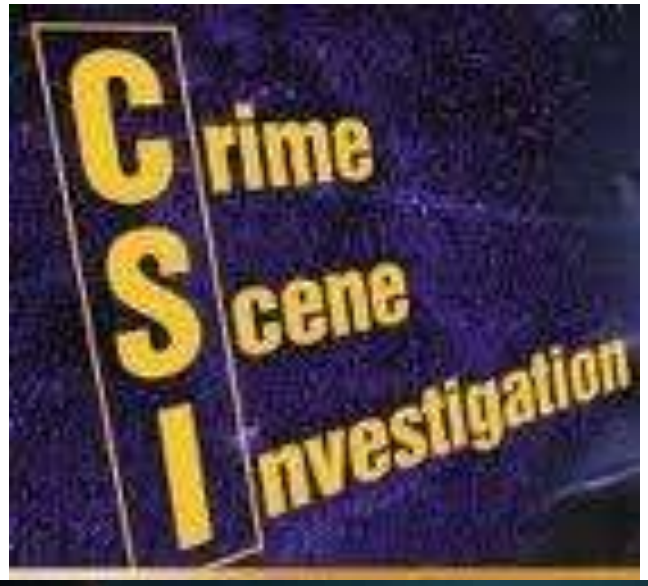


BIRD POLLINATION SYNDROME

- Large, showy flowers
- **Red and tubular**
- Exserted stamens/stigma
- **Produce a lot of nectar**
- Usually lack scent

If someone asks you the following question:

Science and CSI



Comparison to CSI

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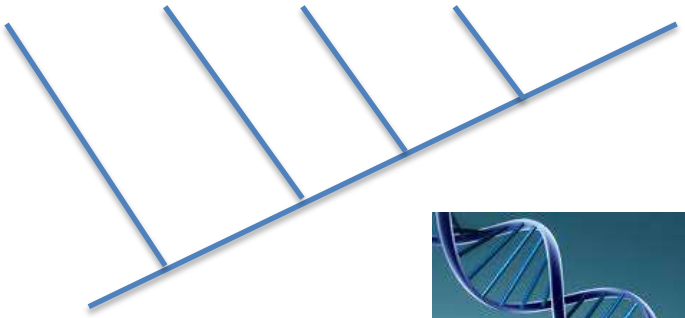
Comparison to CSI



Goal for today

- Start comparing flowers and their morphology
- Extract DNA
- Run PCR
- Summary and prepare for Wednesday

The Plants

- 12 in total
- Different types of pollinators
  - Hummingbird
  - Bee
  - Butterfly



Hummingbird Pollinated

Maltese Cross

Cardinal Climber

Petunia

Bee

Snapdragon

California Poppy

Empress of India

Blue Daze

Butterfly

Pentas

Lantana

Vinca

Unknown

Blue Flax

Nicotiana

Thinking about flowers

PLANT MORPHOLOGY AND DNA EXTRACTION

1. Select four plants for morphological and genetic analysis. Record their names below.

Plant Number	Plant Name	Description of Plant
1		
2		
3		
4		

2. Observe and describe your four plants. As a group, identify floral characters you can use in order to group them by similarity. Which plants are most similar and why? Draw and describe below. Do you think the morphological relationships you describe also indicate genetic relatedness?

Hands on Techniques

- Any ideas why we would do the molecular techniques we will be learning today: extracting DNA and doing a PCR?

Hands on Techniques

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- Think about examples from popular TV shows, such as CSI?

CSI and who is the victim

- http://www.youtube.com/watch?v=6iFDphWXjw4

DNA extractions

- Label tubes
- Take hole punch of leaf material
- Extraction solution
- Cook at 95°C for 10 minutes
- Dilution solution

Follow protocol on hand outs to extract DNA from the four plants at your table

- Collection tubes
- Extraction buffer
- Dilution buffer

Now what do we do?

- We isolated DNA from the plant material into a solution form.
- Will this tell us what species the plant is, just like we found out the victim's identity?

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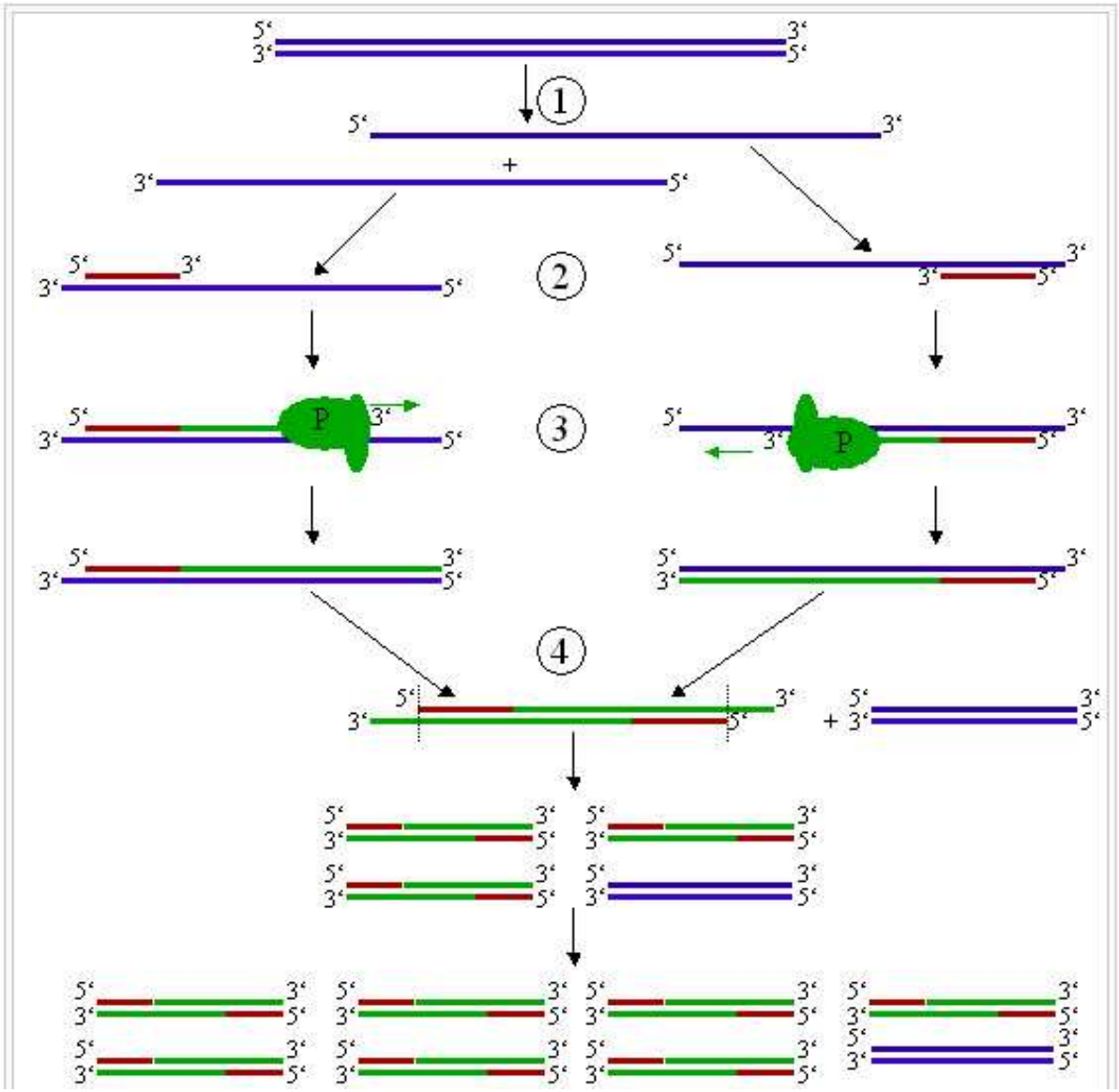
- We isolated DNA from the plant material into a solution form.
- Will this tell us what species the plant is, just like we found out the victim's identity?
  - Not quite yet
- Additional step needed

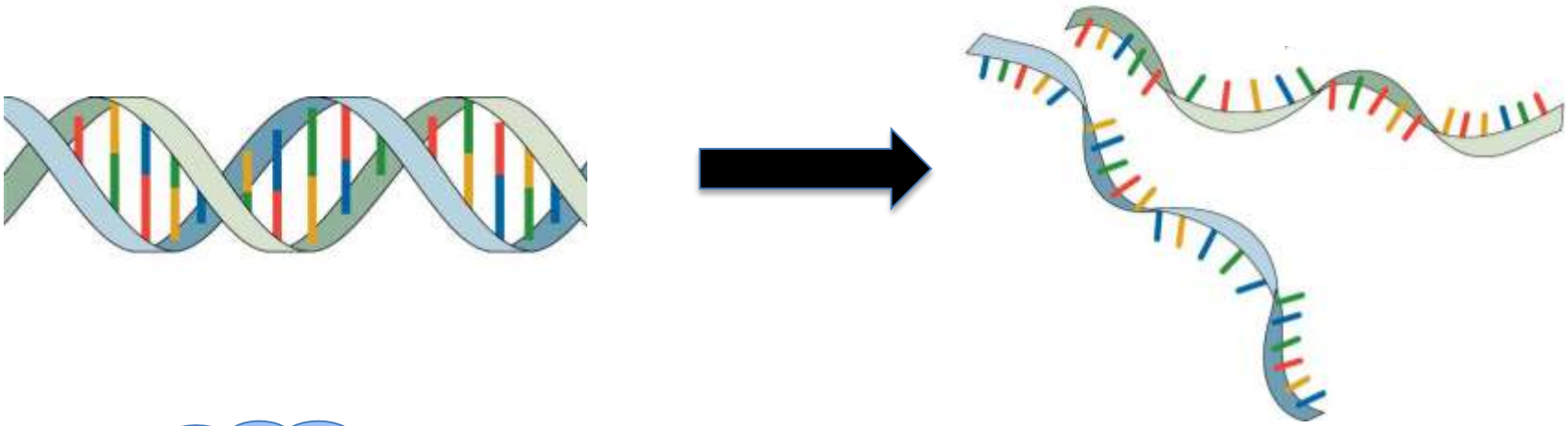
PCR

- Polymerase Chain Reaction
- Amplify small section of DNA, makes many many copies
- Will use common markers



http://serc.carleton.edu/microbelife/research_methods/genomics/pcr.html

How PCR works

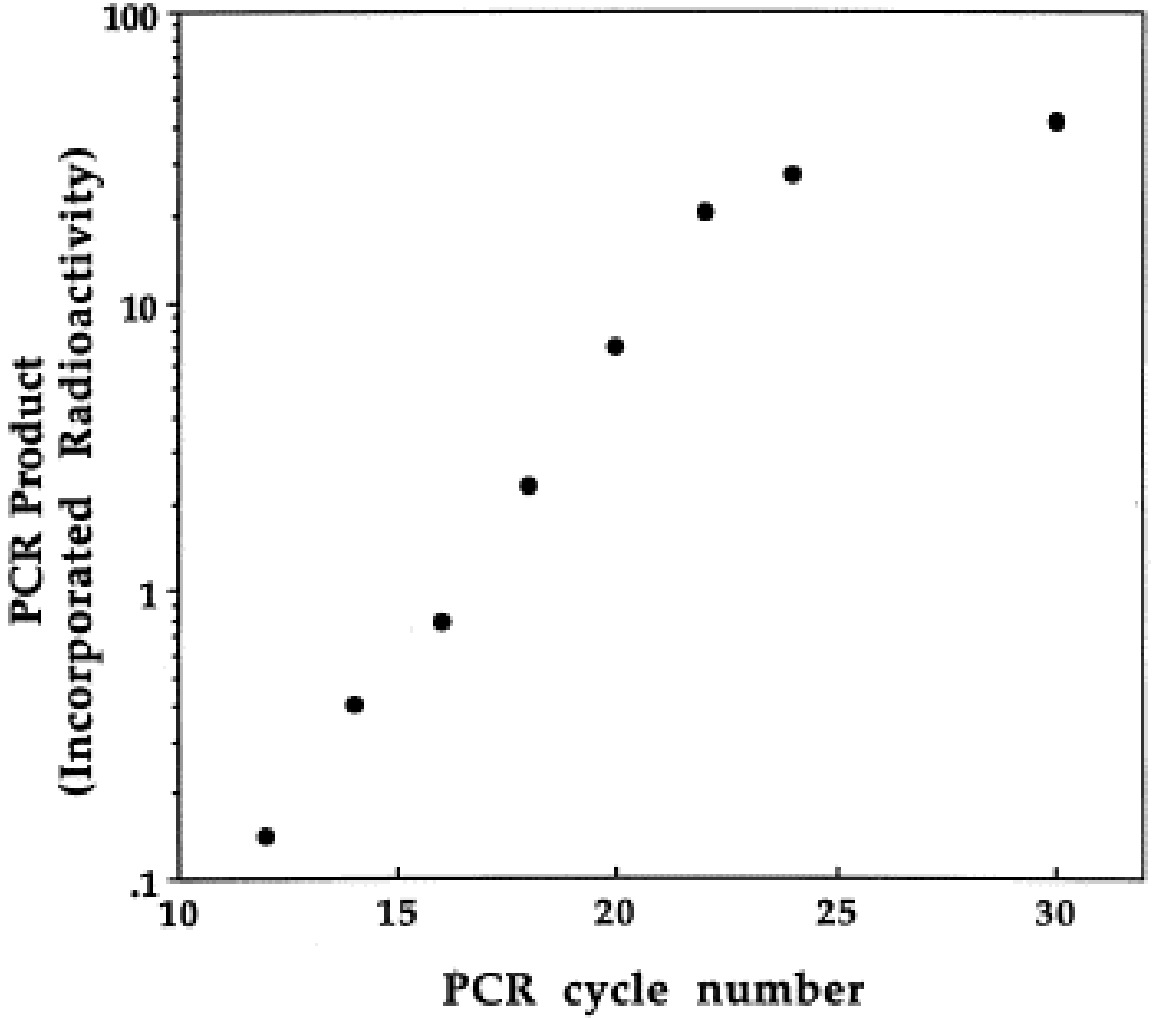


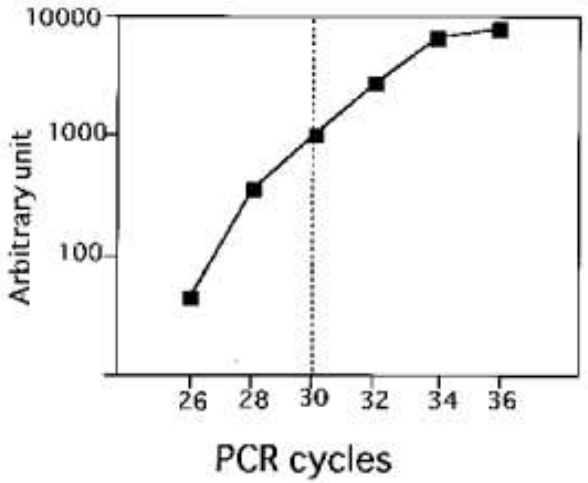
Melting

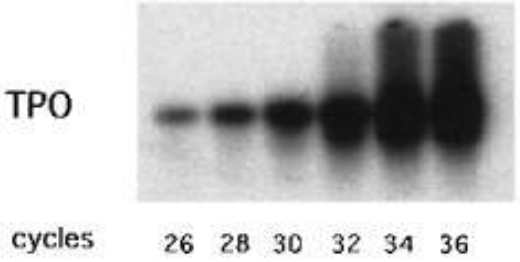
Annealing

Extending

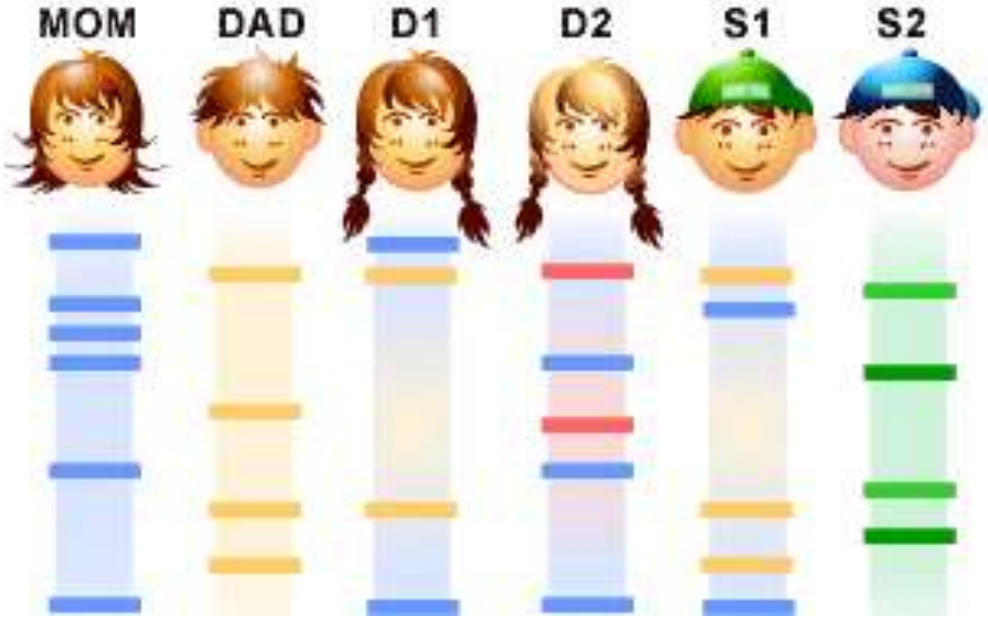
Increase in product

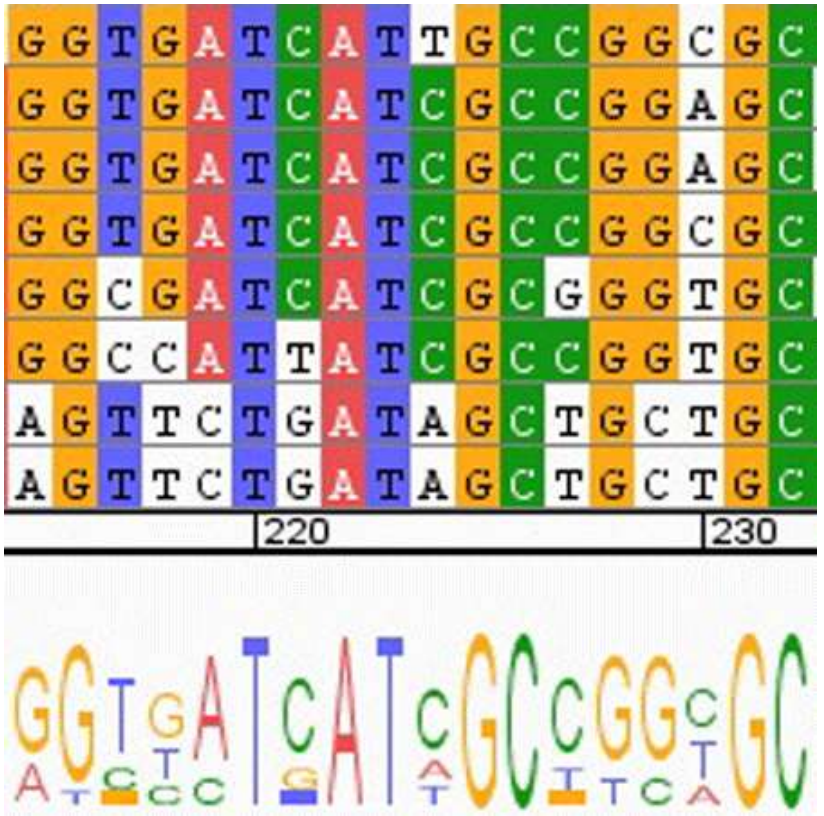






Why do PCR?





Your turn to do a PCR

1. Identify the following reagents at your student workstation, or collect from a common station:

Tube Label	Contents	✔
PCR Mix	REDExtract-N-Amp PCR Ready Mix (Contains $MgCl_2$, dNTPs, Taq Polymerase)	
Water	Sterile water	
Forward	Forward primer	
Reverse	Reverse primer	
Positive	Positive control	
1-4	Your plant DNA samples from the previous procedure	

2. Vortex and centrifuge all reagents.
3. Label six 0.2mL PCR tubes: 1-4, +, and -. Include your group identifier on each as well.
4. Prepare your PCR master mix in a clean 1.5mL microcentrifuge tube. You will perform 6 PCR reactions (4 leaf extraction DNA samples, positive control, and negative control). To ensure you have enough PCR master mix, you will prepare for 7 reactions. Be sure to change your tip between each reagent.

1 PCR Reaction	7 PCR Reactions	✔
10µL REDExtract-N-Amp Ready Mix		
2µL of Forward Primer		
2µL of Reverse Primer		
2µL of Water		
4µL of Leaf Extract		
20µL Total Reaction		

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Not in Master Mix

Summary

- Extract DNA?
  - Why did we do this?

Summary

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  - Why did we do this?
- PCR
  - How does this work and why is it necessary?

Summary

- Extract DNA?
  - Why did we do this?
- PCR
  - How does this work and why is it necessary?
- Flowers
  - If you look at a flower, do you start getting ideas of what may pollinate it?

Goal for Wednesday

- Run PCR product on gels
- Talk about how we get sequence data
- Construct morphological phylogeny
- Construct molecular phylogeny
- Compare trees and the evolution of pollination syndromes

Any Questions?