PLANTS: FORM AND FUNCTION
Tree of Life: focus on **eukaryotes** (cells with nucleus): **plant & animal kingdoms**
Plant Evolution

- Green marine algae
- Adaptations to land
  - H₂O loss
  - Waxy cuticle: keeps water in
Adaptations to land

• Gravity: at first, low near ground

Moss: Ireland: heating/cooking
Adaptations to land

• Later: “standing tall”: evolved vascular system

• Tubes: carry water & nutrients

• Similar: human blood vessels
• First plants: seedless
• Later: seeds evolved

WHY ARE SEEDS IMPORTANT?

• Plants can’t walk around
• Seeds: dispersal of plants: spread babies around
• Different environments: better chance- survival
What is a seed?
What is a seed?

- Baby plant: embryo (combination of egg + sperm)
- Has own food supply: carbohydrates, fat, protein
- Tough outer coat
- First seed plants: evolved

pine & fir trees (cone plants)
Example: seeds inside pine cone
Do plants have sex?

Sort of:

1. Sperm inside pollen grain (pine pollen) → wind
2. Fertilizes egg: inside female pine cone (miles away)
3. Seed (embryo): sprouts new tree
1. Wind carries pollen to female cone.

2. Sperm within the pollen fertilizes one egg within the cone.

3. Embryo begins to develop within seed.

4. Seed germinates

5. New pine tree begins to grow
Plant sex: help from animals

• **Sperm** inside pollen grain on plant surface

• Plant attracts animals:
  A) **Nectar** (sugary water)
  B) **Fragrance** (smell)
  C) **Bright colors** (flower)
Animal picks up pollen

egg → another plant

fertilization → embryo inside seed

Baby plant germinates

Big plant
• **Fruits**: fleshy coating around seeds
Seeds wrapped in **burrs**: dispersal

(b) Burrs help seeds travel
Finally: during time of dinosaurs

- Flowering plants evolved
- Dominant plant today: corn, rice, (food crops), roses, tulips, most trees
Why are plants so important to us?

1. Everything we *eat* directly: wheat, rice, corn, soybean

or indirectly:

all animals that eat plants
GRAINS

- Cereals, breads, crackers, rice, pasta, snacks
- Grains come from seed plants: wheat, oats, corn, barley, rice
All grains start out **whole**: all parts together, not broken up.
Whole vs. Refined Grains

- **Whole grains**: natural, rich in vitamins, minerals, fiber

- **Refined grains**: broken apart (milled), processed (bleached, degerminated) by food companies
Refined Grains

• Why processed?
  Softer
  Whiter
  Shorter cooking time (white vs. brown rice)
  Longer shelf life
Refined grains: loss of nutrients & fiber

- Some nutrients, fiber (not all) added back = “enriched”, “fortified”

- Some products: mixture whole + refined grains
Refined Grains: Foods

- Corn bread
- Corn/flour tortillas
- Couscous
- Crackers, pretzels
- Grits
- Noodles, pasta
- Cornflakes
- White bread, buns, rolls
- White Rice
Whole grains: better for you

Risk:
1) heart disease/stroke
2) diabetes
3) help prevent weight gain
Whole Grains

• More nutrients + fiber
• Fewer calories
• Low in fat
• Rich- antioxidants
Whole Grains: How to find them

- Look at **ingredients**
- First key words: “whole grain”, “100% whole grain”
- “Multigrain, seven grain, twelve grain” ≠ Whole grain
Why are plants so important to us?

2. \( \text{O}_2 \) from photosynthesis

3. Trap “greenhouse gas”: \( \text{CO}_2 \) (global warming)

One maple tree during the summer absorbs: 1000 pounds of \( \text{CO}_2 \)
Why are plants so important to us?

4. **Medicines**: atropine for heart attack patients
PLANT MEDICINES

- **Atropine**: Pupil dilator - eye exams
- **Digitalis**: Heart medication
- **Menthol**: Cough medicines
- **Morphine** (opium poppy): Pain reliever
- **Quinine**: Malaria prevention
- **Taxol** (Pacific Yew): Ovarian, breast cancer drug
- **Curare**: Muscle relaxant during surgery
- **Vinblastine**: Leukemia drug
Why are plants so important to us?

4. Lumber: building

5. Beauty
6. Biofuels

Corn → Ethanol

Problem: trade-off food vs. fuel
Possible solution: Exxon Mobil
Developing: algae powered cars
Algae absorb CO₂

- ↓ Greenhouse gas (global warming)
- Use energy in algae as biofuel
- Doesn’t compete with corn or sugar cane as food source
Algae Farms: Biological Recycling
American Indian Reservation in Colorado: 300 days sun/year

- Algae (love CO₂) tanks built near natural gas processing plant
Plant Structures: Focus on Angiosperms

- **Flowering plants**
- Seeds enclosed inside **fruit**
Roots

Functions:

1. **Grow** to water and minerals
2. **Absorption** → pass materials up to plant
3. **Anchor** plant in soil
4. **Some roots:** food storage (sweet potatoes, carrots)
Root Types

A) **Taproot**: 1 large root + smaller roots

Ex. Dandelion
• Root hairs: \(\uparrow\) surface area-absorption
B) **Fibrous roots**: many small roots- all same size

Ex. Marigold
Why are roots so important?

- Plants: continuously **lose** water from **leaves**
- **Transpiration**: evaporation (like perspiration): “moving the line”
- Tall maple: loses **60** gallons H₂O in **1** hour during summer
- Roots: **replace** H₂O
• Leaves: where **food** is made
• Photosynthesis
Photosynthesis

Sunlight

+ CO₂

+ H₂O

O₂ + Sugar

↓

Starch
Leaves: **Stomata** - pores

- Open (day), close (night)
- Gases:
  - $\text{CO}_2$, $\text{H}_2\text{O}$, $\text{O}_2$ move in and out
Leaf: 
Blade + Petiole (stem)

Cuticle: waxy
↓ H₂O loss
Stems: structure + storage (food)

• Shutting **up** and **down** stem:
  Minerals and water

• Shutting down: Food from leaves (photosynthesis) → rest of plant

• **How does this happen?**
Vascular bundles: like your circulatory system
Vascular Bundles

Xylem
Carries
H₂O & minerals

Phloem
Carries
Food (sugar)
3. Vascular Tissue

- xylem
- phloem
- vascular bundle
- tracheid
- vessel element
- sieve element
- companion cell

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1. Water evaporates from stomata on underside of leaves.

2. Water from stem is pulled up through xylem to replace water lost from leaves.

3. Water is pulled out of soil into roots to replace water lost from stem.
Transpiration: loss of H$_2$O by evaporation: suction from top pulls H$_2$O up.
Redwood Tree

Leaves

\[\text{Football field}\]

Roots
Sugar produced in leaves by photosynthesis

- Fruits
- Stems
- Roots

Sugar moves through **phloem**
Flower: where plant sex happens
Plants coordinate: annual flowering with **day length** (spring/summer): make proteins → flowering
Single flower: both boy & girl
Male & female reproductive structures
Some plants: “self fertilize”
Example: pea plants

BORING: not much variety (mixing genes)
Better for evolution: sexual reproduction with other plants

Sperm (one plant) \( \Rightarrow \) Egg (another plants)

“Mixing genes”: better- natural selection

Better: adaptation: changing environments
Flower Parts

Stamen: anther - pollen grains (sperm)
Carpel: ovary - contains egg: fertilization and baby plant embryo develop
Angiosperms: **Asexual Reproduction**

Sperm $\times$ egg $\rightarrow$ new embryo

Instead: “cuttings” from original plant $\rightarrow$ grow “new” plant

New plant: exact genetic replica of original (clone)

Ex. Cuttings- orange tree in Brazil (1800’s) today’s navel orange trees
Plant Hormones

• Similar - plants and animals
• Chemical messengers: released one place → carries out activity another place
Plant hormones: What they do

1. Help roots and stems **grow** (cell division)
2. Help leaves fall off (autumn)
3. Help **fruits** grow
4. Ripen fruit
5. Help baby seeds sprout (germination)
Plant Growth
• Occurs at tips of roots and shoots

Special areas:
Apical Meristems
Growing points
Active Mitosis
• **Primary growth**: at tips of roots and shoots
• Plant grows **longer**
• Example: **herbaceous plants** (never make wood)
• Example: orchids/strawberries
• **Secondary Growth**: thickening

• Example **woody** plants (trees & shrubs)

• Cork cambium (type of meristematic tissue): like cell factory → pushing cells outward

  BARK
Plants: no nervous system but still respond to environment

- **Response to gravity**
- Seed in ground: \( \uparrow \) shoots \( \downarrow \) roots

“Sense gravity”
• Response to light
• Response to light: **phototropism**
• **Tropism**: “a turning response to a stimulus”
• Important: **photosynthesis**
• Hormone molecules **shift** in response to sunlight position
• Result: **differential growth**
Response to touch: one plant wraps around stick or another plant
Response to changing seasons
Photoperiodism: plant responding to change in amount of daily darkness vs. light

In autumn: darkness longer

Less chance: photosynthesis, less H₂O in ground (frozen)

So what does the plant do?
Plant Dormancy

- ↓ Growth
- ↓ Metabolism
- Uses stored food over winter
• **Abscission** layer: disconnects leaf stem from branch
• **Chlorophyll** starts to break down
• Now see “hidden” pigments: yellow, orange, blue, red
• **Deciduous trees**: leaves fall off
Flowering plants: 2 ways to classify them

1. How long they live

2. Their anatomy
How long they live (lifespan)

- Seed (baby plant) → germinates (sprouts)
- Grow to adult plant
- Flower (reproduction)
- New seeds
- Death
Lifespan

• 1 year cycle: **annuals**
  Examples: tomatoes, wheat, corn, rice

• 2 years: **biennials**: carrots, cabbage

• Many years: **perennials**: trees, roses, shrubs, grass
Anatomy (structures)

Monocotyledons

“Monocots”: 1

Dicotyledons

“Dicots”: 2

Cotyledon: baby (embryonic) leaf inside seed
Corn: a monocot

Geranium: a dicot
Monocots vs. Dicots: other differences

• Leaves
  & roots
Monocots vs. Dicots: other differences

- **Vascular bundles**
  - Monocots: scattered throughout stem
  - Dicots: arranged in a ring in stem

- **Type of growth**
  - Monocots: only primary growth
  - Dicots: may have secondary woody growth

- **Flower parts**
  - Monocots: multiples of three
  - Dicots: multiples of four or five

- **Examples**
  - Monocots: orchids, wheat, rice, bananas
  - Dicots: oak and maple trees, cacti, sunflowers