Cells and Microscopes

See What You’ve Been Missing
The Microscope: we’ve come a long way

- Anton van Leeuwenhoek: Dutch shopkeeper
- 1670 first saw “little animals”- mouth scrapings: hand-held magnifier
Why are cells so small? What limits their size?

Answer: cell surface area

Taking in: food & oxygen

Removing: wastes & other materials
2 cells types:

#1 Eukaryotic cells ("true" nucleus)

DNA (genes) inside nucleus surrounded by membrane package

Example: our cells & plant cells
#2 Prokaryotic cells ("before" nucleus)

DNA **not** inside a nucleus

Example: **bacteria**
A look inside one of your cells

• Organelles: “tiny organs” inside cell
• Each: unique job to do
• Working together
nuclear pores
DNA
nuclear envelope

cytoskeleton

smooth endoplasmic reticulum
free ribosomes
cytosol
lysosomes

Golgi complex

rough endoplasmic reticulum
plasma membrane
transport vesicle
mitochondria

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Organelles: What they do

• A trip through one of your cells
• “Follow how a protein is made and sent outside your cell”
• Example: Insulin made in pancreas cell → blood
• Control blood glucose
DNA in genes has instructions: how to build insulin protein

#1 Make photocopy of instructions onto messenger RNA (message: how to build insulin)

#2 mRNA → pores → cytoplasm

ribosome attaches

(where protein made)
RNA uses message: builds insulin

- Hooks together different **amino acids**: specific for **insulin**
- After short time: RNA attached to its ribosome: “docks” with endoplasmic reticulum (ER)
**ER**: hollow membrane **tubes** in cytoplasm: extension of nuclear envelope

Called: “**rough**” **ER**: many **ribosomes** attached: making **proteins**
Protein needs further **processing** before final insulin released from cell

- Incomplete protein surrounded by “carrier pod” (vesicle)

- Pinches off moves to/fuses with **Golgi complex**
In Golgi: “finished” protein made

- Enters another “carrier pod”
- Moves to plasma membrane
- Ejected to outside of cell
IN SUMMARY

DNA → mRNA → Protein
VESICLE → GOLGI → OUTSIDE CELL
(PROTEIN)
• **Insulin** → **blood**: helps lower blood glucose after meal rich in carbohydrates

• **Diabetic**: 1) not producing enough insulin or 2) cells **not** responding to insulin

Result: **high blood glucose** (dangerous)
Smooth ER

- Where fat (lipid) is made

Examples

- Liver cells: make 80% cholesterol (fat) in your body
- 20% cholesterol from diet
- Woman’s ovaries $\rightarrow$ estrogen (steroid fat)
- Man’s testes $\rightarrow$ testosterone
Smooth ER

- **Detoxification**: harmful chemicals & alcohol

- **Alcoholic**: ↑ Smooth ER
  ↓ Blood alcohol
Other organelles

- **Lysosomes**: “acid vats”: enzymes
- **Recycling center**: old parts broken down (digested) → cytoplasm → re-used
- **Bacteria** → broken down → outside cell
Lysosomes: when things go wrong

- **Fat storage diseases**: genetic absence of enzymes - breakdown of fat
- Fat clogs lysosomes
- Damage: nervous system/other parts of body
Lysosomes: when things go wrong

- **Black lung disease**: miners
- Lysosomes $\rightarrow$ silica fibers (sharp)
  - leak acid $\leftarrow$ holes
  - lung tissue scars
Mitochondria: where energy produced
Cell Respiration: inside your cells

• Energy trapped in chemical bonds: carbohydrates, fats, protein

• Break chemical bonds → energy
ENERGY  +  P  +  ADP  $\rightarrow$ ATP  
(from chemical bonds) 

Energy release: all your body activities
Cell Respiration

Glucose + O₂ → CO₂ + H₂O + ATP’s
Cell Respiration

Glucose + O₂ → CO₂ + H₂O + ATP’s

Metabolic Poisons:

- Carbon Monoxide (cars)
- Hydrogen cyanide (cigarettes)
- Hydrogen sulfide (rotten egg smell)
Breathing and Cell Respiration

Breathing

Lungs

Bloodstream

Muscle cells carrying out Cellular Respiration

Glucose + O₂

CO₂ + H₂O + ATP
Mitochondria: foreign invaders

- outer membrane
- inner membrane
• Bacteria invaded our ancestors’ cells: billion years ago
• Evolved into mitochondria
• Mitochondria- have own DNA
• Live inside our cells: help us produce energy
• Symbiosis: “living together”
Cytoskeleton: “tangled forest”: proteins in cytoplasm
#1 Microfilaments:

- Support (structure)
- Movement: capture prey (false feet: “pseudopods”)
#2 Microtubules:

- Support/structure (scaffolding)
- **Monorails**: move vesicles - place to place inside cell
Cilia & Flagella

- **Cilia (hairs):** extensions of microtubules
- **Move back and forth:** move things along
- **Nasal passages:** helps us “smell” food
Cilia: paramecium- movement
Cilia: Your Respiratory Tract
Flagellum: extension of microtubule

Sperm cell: tail - swimming to egg
The plant cell: similar to animal cell

**Diagram:**
- **Animal cell**
  - Nucleus
  - Smooth and rough endoplasmic reticulum
  - Ribosomes
  - Cytoskeleton
  - Cytosol
  - Mitochondria
  - Plasma membrane

- **Plant cell**
  - Nucleus
  - Smooth and rough endoplasmic reticulum
  - Ribosomes
  - Cytoskeleton
  - Cytosol
  - Mitochondria
  - Plasma membrane

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The **plant cell**: differences

1. **Thick cell wall**: outside plasma membrane
   - **Strength**: structure
   - **Protection**: injury
   - **Rigid**: less movement possible
   - **Made of** *cellulose* (fiber)
   - **Wood**: mostly cell walls
Central vacuole: holding tank: water, nutrients, wastes

- Plant cells: 90-98% H₂O
- Animal cells: 70-85% H₂O
Chloroplasts: Chlorophyll, photosynthesis
Photosynthesis
Light energy

Carbon dioxide + Water → Glucose + Oxygen gas

Starch
Plants exchange gases with air

Stomata: openings

Figure 3. A portion of the water that plants absorb through their roots escapes through their leaves via stomata. The microscopic pores, which open and close, are pictured above in a magnified maize leaf and, at right, in a labeled drawing. Transpiration rates among plants vary but they can be calculated based on the species, their growth rate and temperature and humidity in their environment. Trying to reduce transpiration by re-engineering plants to close their stomata more frequently would decrease access to CO₂, which plants need to grow.
Do cells talk to each other?

• Cells together: **tissues**

• **Channels** connecting cell-cell

• **Exchange:** molecules, electrical signals (nerve impulses)