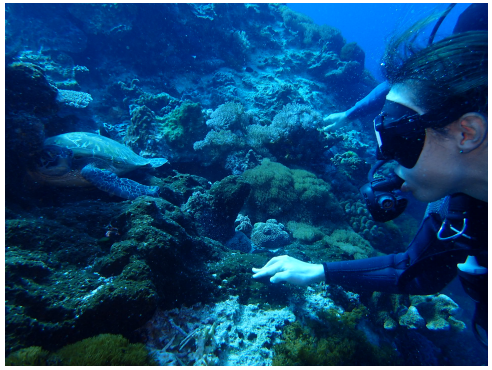
BUILDING BLOCKS OF LIFE

Introductions, then…

Tissues, Cells, Compartments, Organelles

Welcome to BIEN 5010!

- Course coordinator: Angela WU
  - I am a pure-bred bioengineer…
  - Joined HKUST in 2015
  - Research Area: microfluidics, single cell genomics, development of novel molecular biology assays/methods
  - Fun Fact #1: I got my scuba diving certification in 2015, and then didn't get to use it for four years! 2018 tried to go Okinawa but was ruined by typhoon Trami; this year finally got to go diving in Taiwan!
  - Fun Fact #2: Just two months ago I completed a 13-day, 1000+ km biking trip, riding around Taiwan!
  - **Office hours:** by appointment, via zoom until further notice



Our teaching objectives

3. Course intended learning outcomes (CILOs)

1) Describe the central dogma of molecular biology, and be able to recall the various molecular participants (molecules, proteins/enzymes) involved in the components of the central dogma. Describe their main physical features and select appropriate tools/techniques for characterizing them.
2) Explain the mechanisms and functions of basic molecular biology assays, including PCR, qPCR, gel electrophoresis, molecular cloning, protein separation and purification; be able to analyze and interpret results of above assays.
3) Compare different types of imaging tools, and describe their usage and importance in modern biotechnology/medicine.
4) Explain what a stem cell is, and compare differences between embryonic stem cells, fetal stem cells, adult stem cells, and induced pluripotent cells; recall modern applications of stem cell therapies, and explain the mechanism of action for these therapies; describe current major challenges in using stem cell therapies in the clinic.
5) Explain and critique recent breakthroughs in molecular biology and bioengineering fields, including those outside your research area; be able to suggest potential applications of these new technologies to a relevant clinical challenge.
6) Present and discuss the taught ideas and concepts with peers with clarity and evidence-based reasoning; collaborate with team mates with positive attitude and strong work ethic in a group project setting.

- We have CILOs 1-6:
  - CILO 1-4 are the knowledge that you should have by the end of the course – details about molecular biology that you will learn in the class
  - CILO 5 – Be bold; be creative; be critical
  - CILO 6 – The human aspect of any research

Our assessment scheme

- **Midterm: 30%**
  - One written exam will be given in class on 31 March. The exam will test cumulative knowledge.
- **Class Participation: 20%**
  - Active participation and in-class discussion.
  - Each student must represent their discussion group in presenting their discussion AT LEAST ONCE in the semester to receive non-zero participation credit.
- **Final project: 40%**
  - Final project consists of a group presentation done in a team, plus an individual written paper
  - Presentations will take place on 12 and 19 May, via zoom or in class depending on the situation. We will update you as soon as possible.
- **Peer evaluation: 10%**
- **Exercises: Optional**
  - Prior to exams, take-home exercises and tutorials will also be provided. These exercises will not be graded.

4. Assessment Scheme

Midterm: 30%

One (1) written exam will be given during class time on 31 March. The exam will require recall of basic concepts taught in class in the form of a written exam.

Assesses CILOs 1-4

Class Participation: 20%

Active participation and in-class discussion with peers are critical to the understanding of the concepts taught in class. *Due to the special circumstances of this semester's teaching format, when students are required to work in groups and discuss in-class exercises, one student will be asked to summarize the group's discussion points.* ***Each student must represent the group in presenting the discussion summary at least once during the semester in order to receive class participation credit.***

Assesses CILO 6

Final project: 40% (20% group oral presentation; 20% individual written assignment)

Final project consists of a presentation done as a group of four (4). Instructor will give out a few choices of project topics, and students must choose their presentation topic from these options to perform comprehensive literature research on. The goal is to understand in-depth the evolution of a current technology in bioengineering, and how past scientific findings build the underlying foundation for the innovation/technology. Students may propose their own topic, but it is subject to approval by the instructor. Presentations will take place on 12 and 19 May. Each presentation will be 30 mins followed by 10 mins of Q&A. The presentations will be scored based on content clarity, completeness, organization, quality of the critical analysis, as well as quality of the presentation itself. Please refer to the grading rubric for more information on how the presentation will be graded. Each student must also write an individual paper.

Assesses CILOs 1-6

Peer evaluation: 10%

Students will be asked to evaluate their peers' final project presentations, with each group being evaluated as a whole to give a "group score". Within each group, students will also receive evaluations on their contribution to the group from each of their teammates, which will be averaged to give an "individual score" for each student. Overall, each student will receive a final peer evaluation score that is the 50-50 weighted average of the group score (given by the rest of the class) and the individual score (given by their teammates).

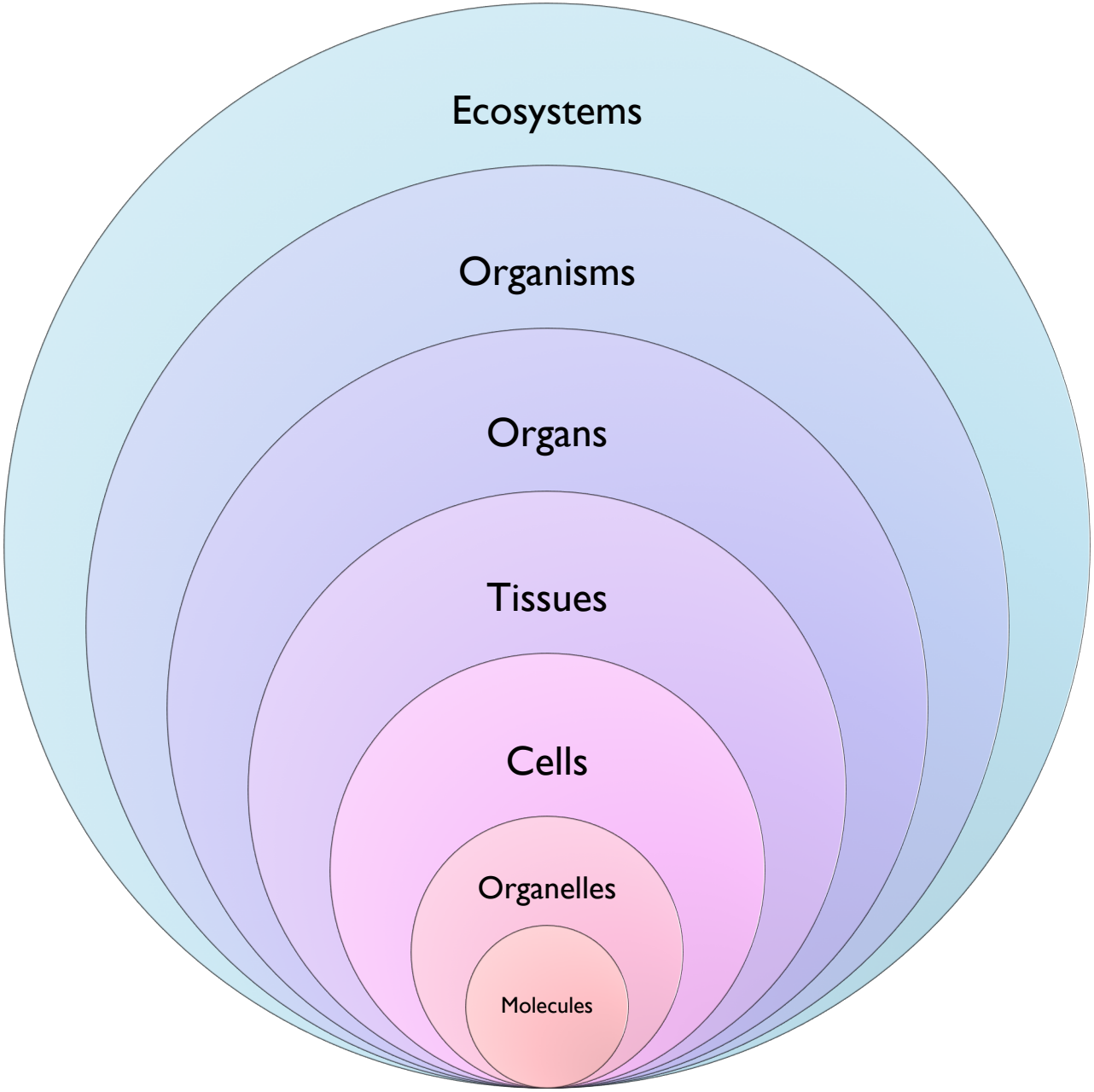
Assesses CILO 6

About Zoom...

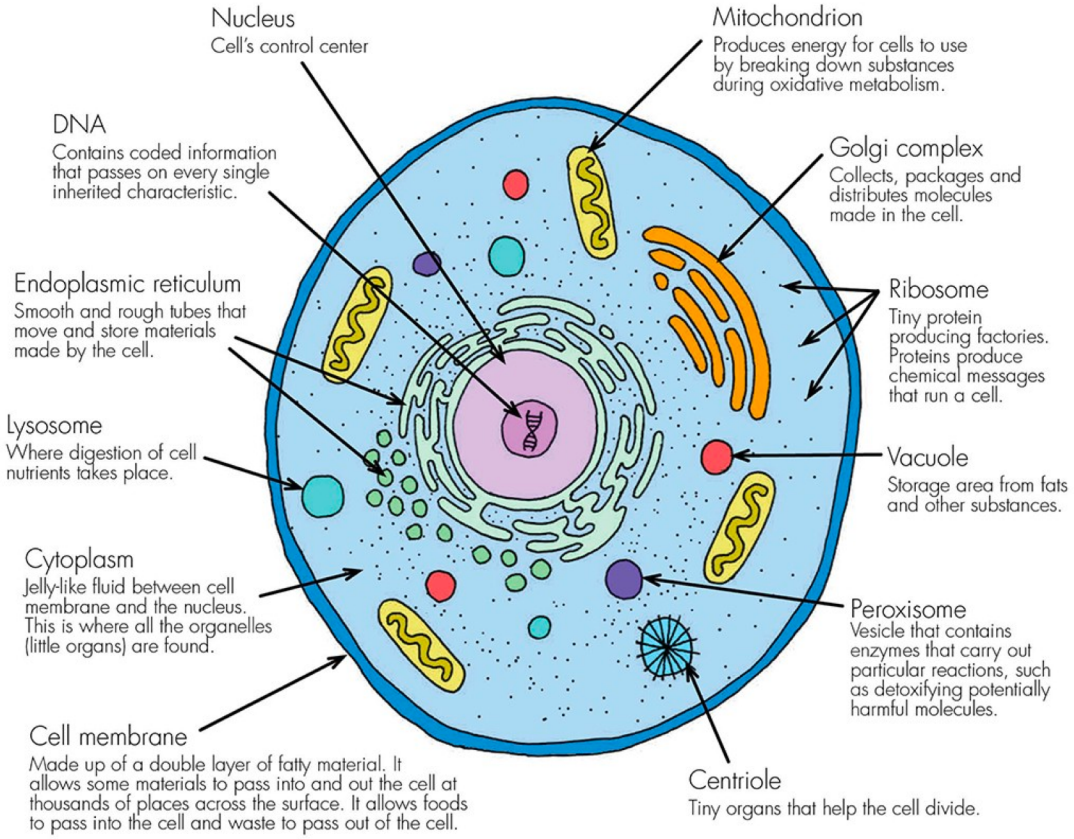
- It sucks – I dislike it as much as you do (if not more)
- Let's all try to make it as effective as possible
  - **TURN ON YOUR VIDEO** so I can feel less silly
  - **TURN OFF YOUR SOUND** unless you are asking or answering a question, so that others can hear my lecture
  - Use your **REAL NAME and Student ID**, so I can see who you are and give participation credit!
  - **"Raise your hand"** if you have questions; you can also use chat to ask questions during the Q&A periods when I will open up the chat room (Anyone doesn't know how to raise hand in zoom?)
  - You can see both my face and the slide if you use "Pin Video", or just use Speaker View, so that I am on top when I am speaking
  - **DO ASK QUESTIONS** if there's something you don't understand!
  - **Be kind to each other (especially me…)** – this is my first time teaching in zoom, and I'm sure it will not be perfect, but I hope that you will be understanding and patient if something goes wrong.

Any questions?

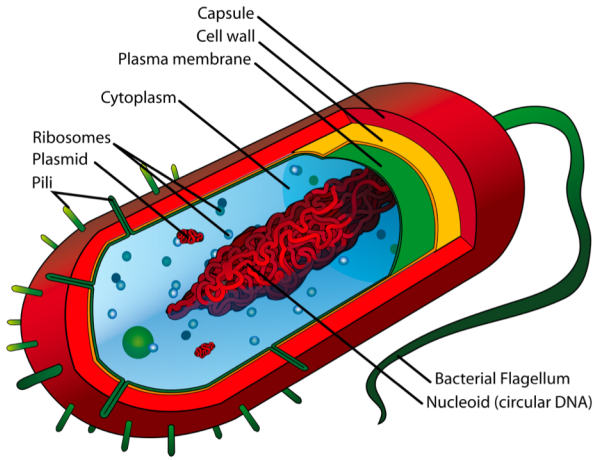
- About the logistics of the course, or basic zoom function?


Ecosystems
Organisms
Organs
Tissues
Cells
Organelles
Molecules

Cells!



Eukaryotes:
~10-40 um in diameter

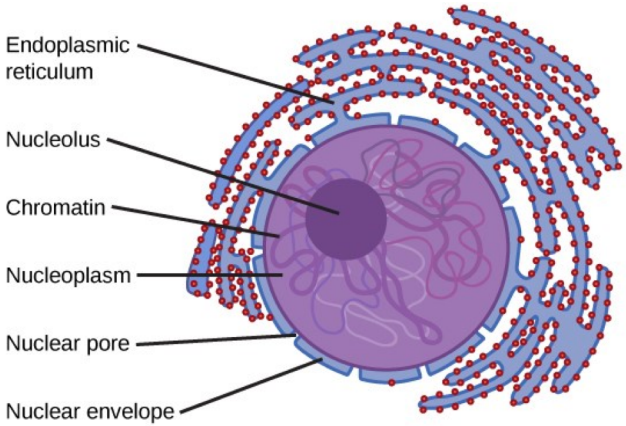


Prokaryotes:
~1-2 um in diameter

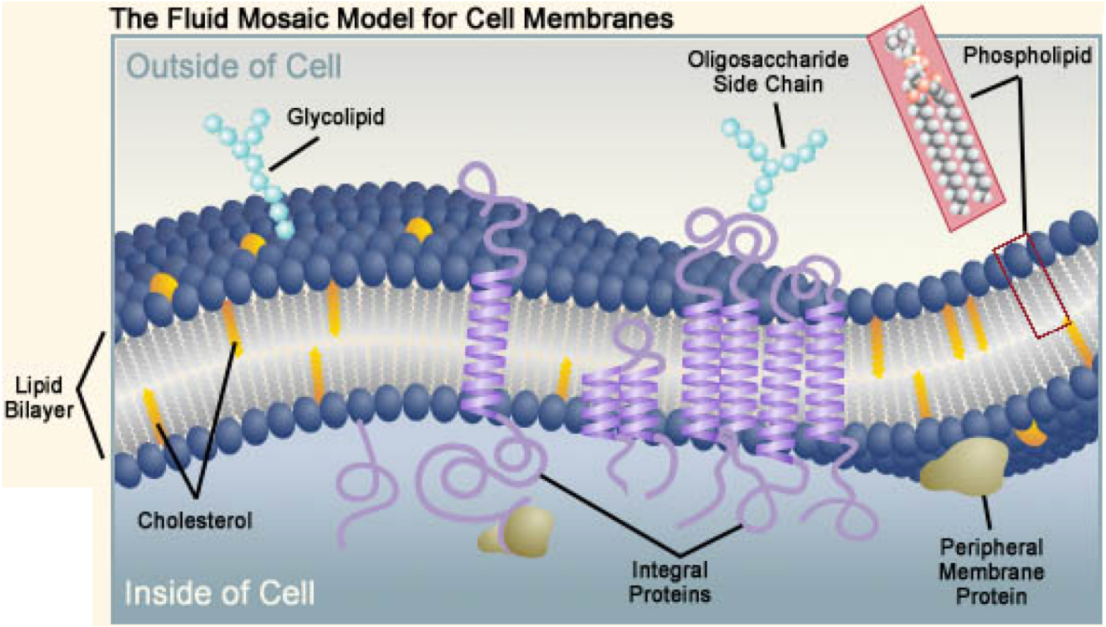
So how many cells are in the human body?

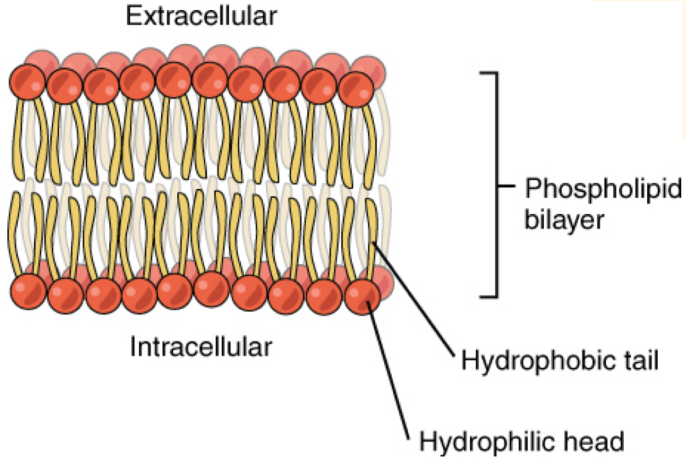
Nucleus

- Command center of the cell
- Has a membrane
- The DNA is in here (chromatin – chromosomes, etc)
- Contains the nucleolus – ribosomal DNA; make rRNA; make ribosomes
- Pores control travel into/out of the nucleus
- Question: What is the advantage of having a nucleus?



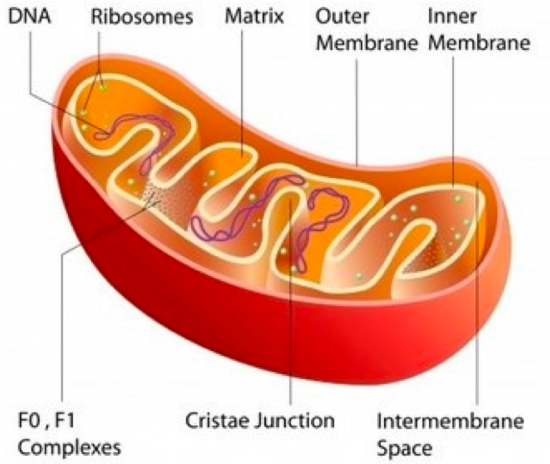
Cell Membrane





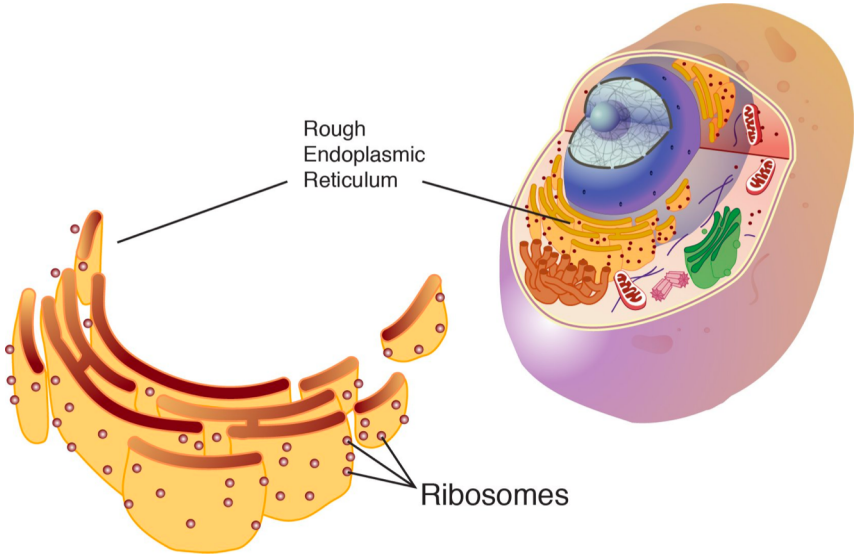
Mitochondrion

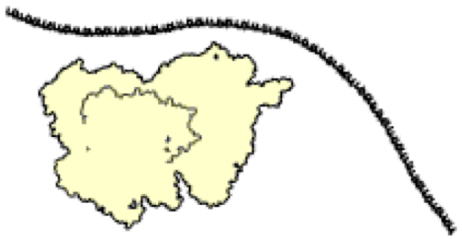
- Metabolism and energy production
  - Respiration! Generating ATP!
- Maternal lineage
- Mitochondrial disease, and aging

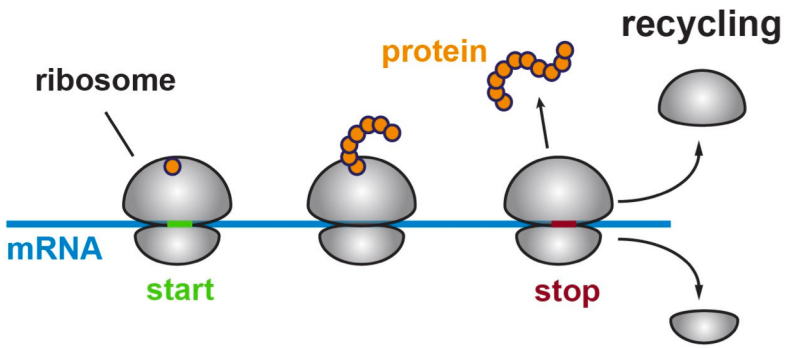


Ribosome

- It makes proteins!
- Needs help from other things in the cell like tRNA



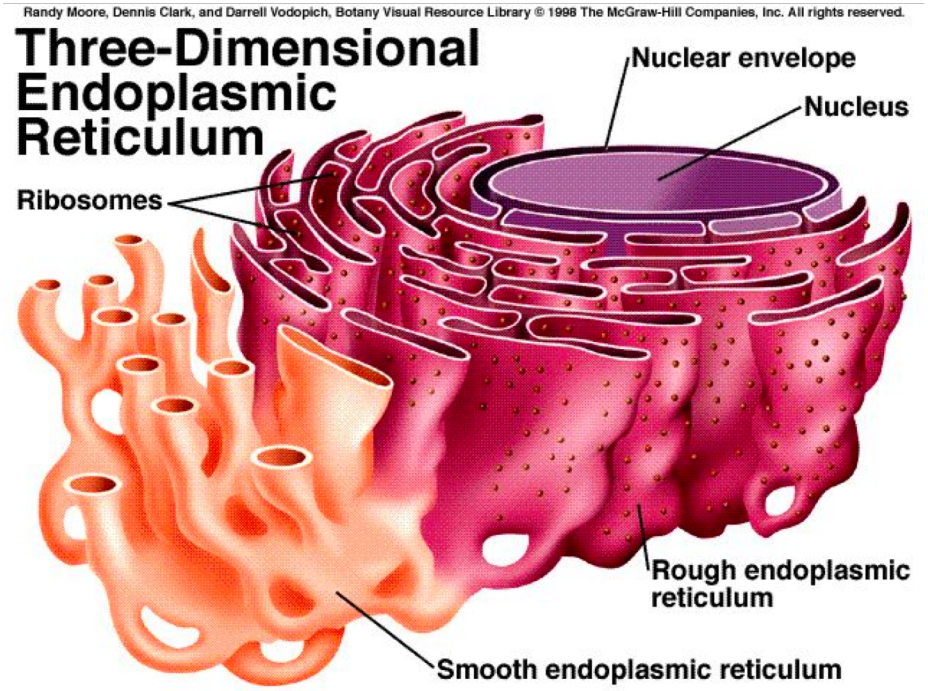




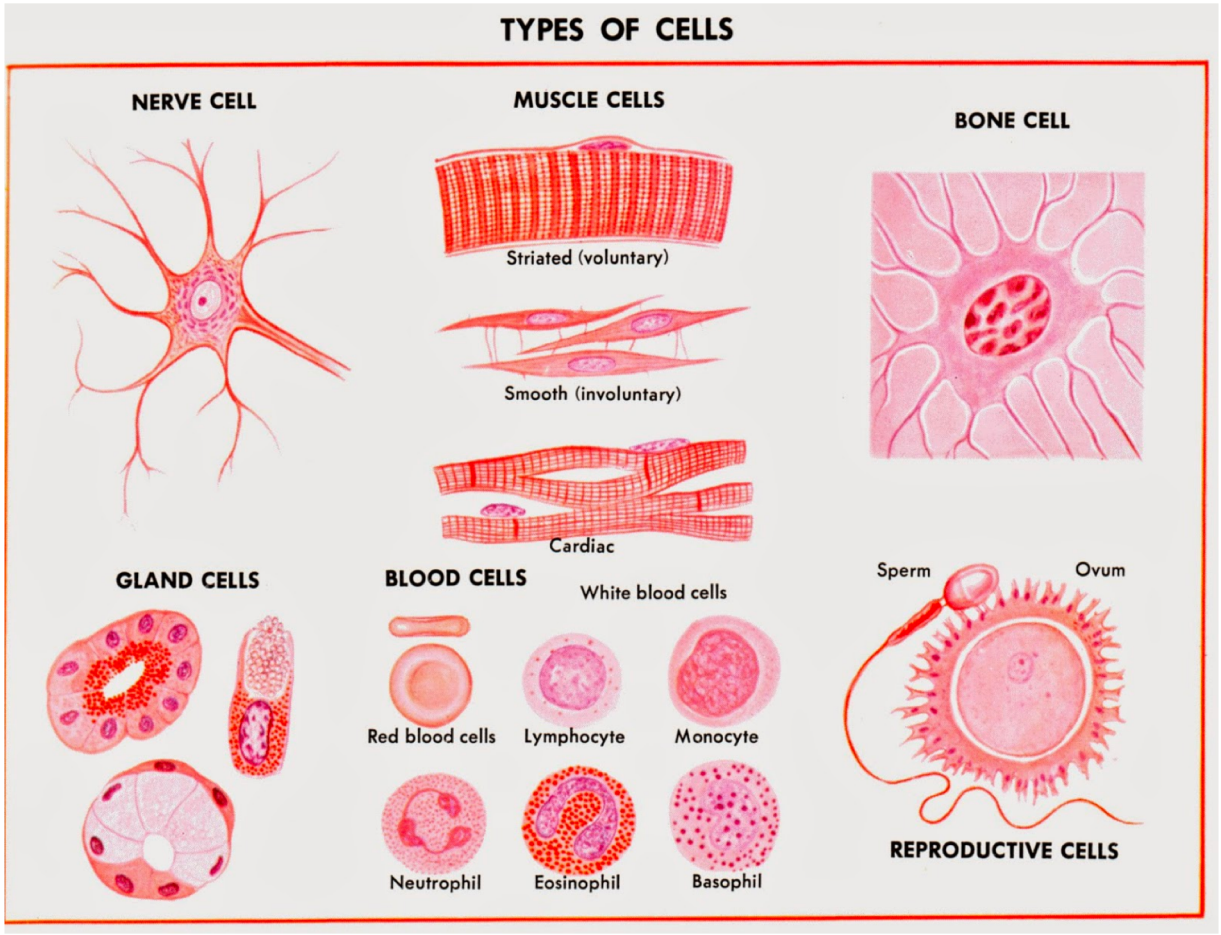
Animated Gif By Bensaccount at en.wikipedia, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=8287100

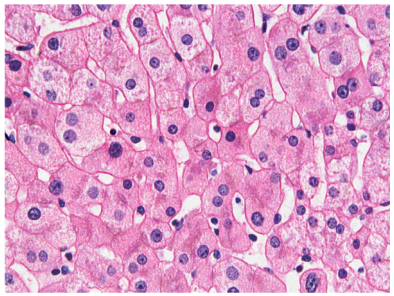
Endoplasmic Reticulum

- Protein production and transport
- Rough ER – has ribosomes on it

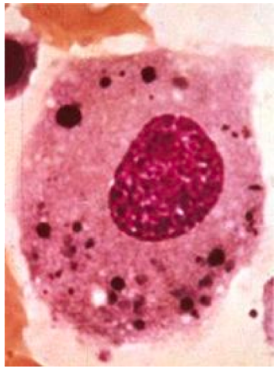


So many cells…





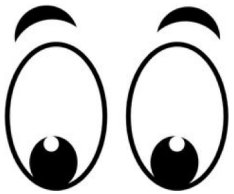
Hepatocyte (liver cell)



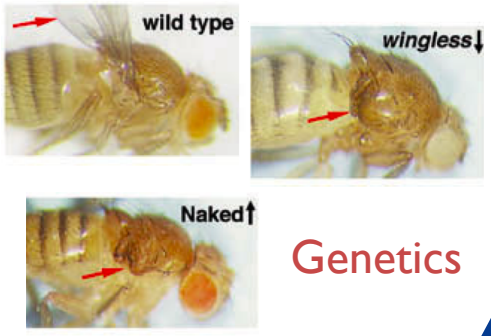
Macrophage

https://wikis.engrade.com/a6thgradescience2/body

A Unified View of Biology



Genomics

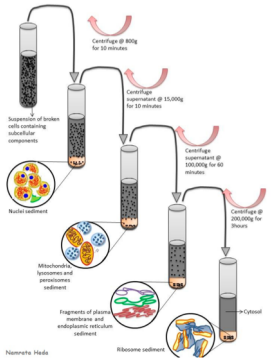


Genetics

BIOLOGICAL FUNCTION

Recombinant DNA

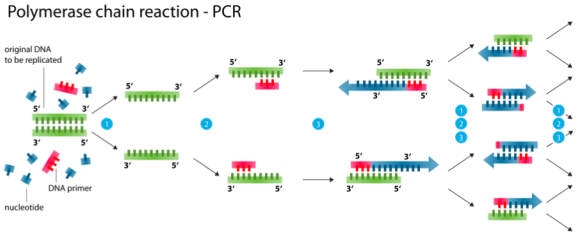
Biochemistry



GENE

PROTEIN

Molecular biology



Concept borrowed from Eric Lander's course at MITx: 7.00x Introduction to Biology - The Secret of Life