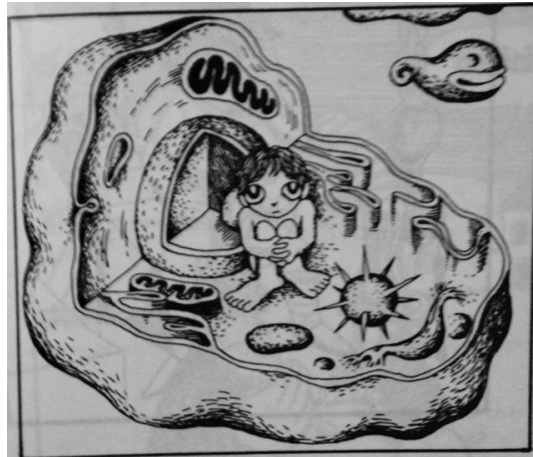


BIOL 377 – Cell Biology

Online with pre-recorded lectures

Dr. Emily Indriolo



Sasaki Maki

1

My contact info

Instructor: Dr. Emily Indriolo

Office: 477 Foster Hall
(yes, there is a 4th floor!)

Phone: 646-2175 (if I'm even in my office)

Email: indriolo@nmsu.edu (to make appointments and for very short answers)

Online/Virtual Office hours: Wednesdays noon-1:00pm
Thursdays 3-4pm. I will use the chat function in Canvas.

*I will only respond to emails that are sent from a NMSU address.
All emails sent from outside sources will be considered SPAM
and deleted immediately.*

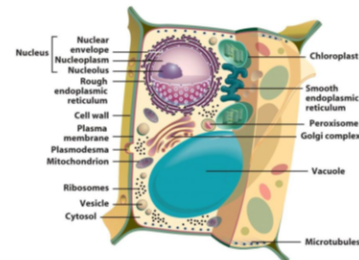


Figure 1-16: Cell and Molecular Biology, 4e (© 2005 John Wiley & Sons)

2

The course syllabus is available on Canvas.

- The syllabus explains all of the elements of how this online class will work.

3

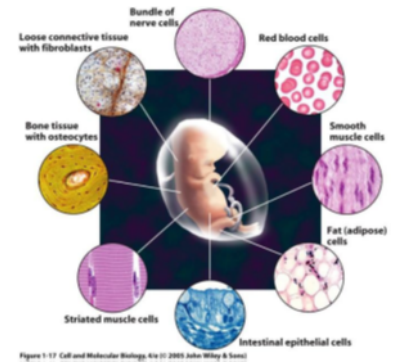
Prerequisites

- Biol 211, Biol 305 (or GENE equivalent)
- ***I will not review*** material covered in Intro bio or genetics. It will be up to YOU to review these concepts if you don't remember them

4

Why study cell biology?

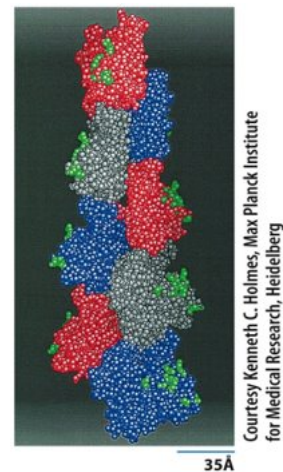
1. Because cells are the fundamental basis of **LIFE!!**
2. Understanding cells from the 'bottom up' can give insight into how biology works on higher levels (tissue, organism, ecology, etc.)
3. Cell biology is tightly integrated with other biological sciences such as molecular biology, biochemistry, etc.
4. Cell biology is essential knowledge for some professions (MD, researcher, etc.)



5

The “big picture” view of 377

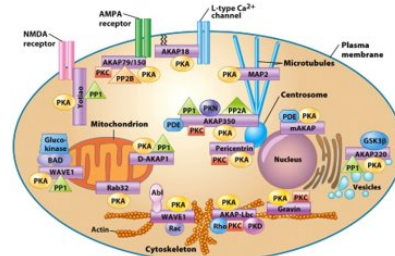
1. Examination of the structure and function of subcellular compartments, organelles, and key molecules. (i.e. all of the functional parts that make up a cell)
2. Provide explanations on how the cell functions and how it interacts with other cells and its environment. (i.e. how all those parts work together)



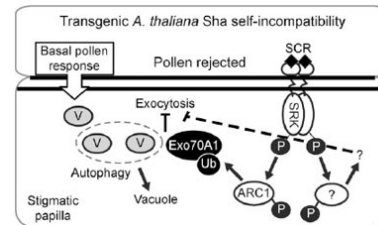
6

Cells are *complex* thus, cell biology is *complex*

- There are tens to hundreds of thousands of different parts to a cell (metabolites, proteins, nucleic acids, etc.). We're only looking at a small fraction of these in this course.
- All of these parts assemble into a cell and actively do things. So you need to know how the parts work to get a glimpse of how cells work!
- We are poor at understanding complex systems. So don't feel too bad if you find this difficult! It's all quite humbling.



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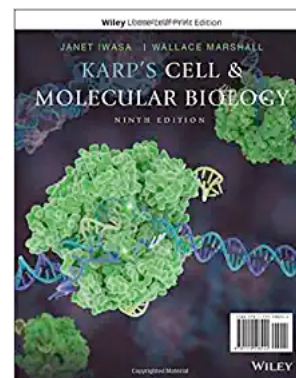


7

The Textbook

“Cell and Molecular Biology -Concepts and Experiments”
9th edition, by Gerald Karp

- Binder-ready and/or hardcover versions
- Also look into textbook rentals etc. . . .



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The Textbook

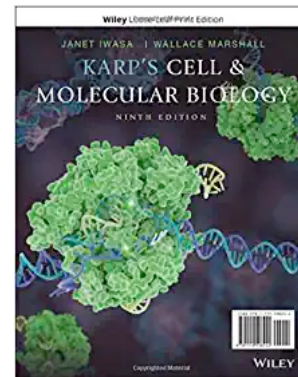
The textbook covers topics in greater depth than we cover in lecture. You will only be responsible for what's in the lecture! (slides and verbal and board)

But... getting the text is **strongly suggested**.

- You may want to know about a topic in greater depth.
- Reading vs. listening for learning
- Different explanations are good!
- Before asking me a question by email, I'll want to see that you read up on it first!

You may consider not getting the text if:

- You're a genius with a photographic memory



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Lecture slides will be available on Canvas

Everything will be on Canvas!

There will be lecture slides, links to the lectures, quizzes and assignments. . . . All of it . . . on Canvas.

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Grading and Exam Schedule

This course will not use fractional grading!

You can use the following points scale as a guide to your overall grade in the course; I reserve the right to adjust the scale in assigning final grades.

A 450 and above
 B 400-449 points
 C 350-399 points
 D 300-349 points
 F 299 and below
 Total points out of 500

- **September Exam 1** - 50 points – short answer questions
- **October Exam 2** - 50 points - short answer questions
- **November Exam 3** - 50 points - short answer questions
- **December Final Exam** - 70 points - short answer questions

Exams will open on a Monday and close on Friday. You must have the Respondus system for your browser.

In class activities – dates subject to change, these are the most loose element of the class. Each assignment is worth 20 points.

Quizzes – there will be a quiz at the end of each topic. Quizzes will open on Thursday and close on the following Monday.

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Missed an exam??

- There are NO deferred midterm exams. If you missed an exam then your grade will be based on the comprehensive final exam section corresponding to the exam
- Thus, you do not need a doctor's note or such if you missed a midterm.
- If you miss the final, you will need to provide appropriate documentation e.g. see details in syllabus



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Faculty of Arts & Science Statement on Academic Dishonesty

Academic Honor

Intellectual honesty is a fundamental expectation of all students in this course and is taken very seriously by the instructor. Work on all assignments must be your own unless explicitly stated in this syllabus or other written instructions for the assignments. Cheating, plagiarism (both intentional and unintentional), and other academic misconduct will not be tolerated. Students judged to be guilty of academic dishonesty on a particular assignment will receive no points for that assignment and the instructors reserves the right to consider more severe penalties such as failure of the course and referral to the Dean and Student Judicial Affairs.

Plagiarism is using another person's work without acknowledgment, making it appear to be one's own. Intentional and unintentional instances of plagiarism are considered instances of academic misconduct and are subject to disciplinary action such as failure on the assignment, failure of the course or dismissal from the university. The NMSU Library has more information and help on how to avoid plagiarism at <http://lib.nmsu.edu/plagiarism/>

Note: cell phones, pagers or electronic translators are explicitly listed as unauthorized materials, and must not be present during tests or examinations.

All Faculty members (and their teaching assistants) have been instructed to be vigilant and report all incidents of academic dishonesty to the Head of the Department.

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Disabilities and accommodations

- If you have a disability and require a classroom/testing accommodation
 - Please bring me the SSD paperwork ASAP
 - See syllabus
 - SSD Office: 208 Corbett; 646-6840

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A bit on mental health

- Life can be hard... university can be hard – there are even documentaries on this now!
- Our current events with Covid-19 have thrown everything into chaos. We survived the spring semester treating this as a sprint. Science is showing us that we need to look at this as a marathon. The furthest that I've traveled since February is Target to pick up 90lbs of kitty litter. I'm not even sure if I'll get to see my family this year. Which sucks. But I have to travel almost 2,000 miles with connecting flights . . . I'm not afraid to be on a plane with other people, they have excellent air systems. It is just everything in between – driving to the airport. Waiting at the airport. Lining up at the airport. Having a connection in another city. Repeating the entire process. Etc.
- How can I do the best to succeed in this class?
- Stick to a schedule – wake up at the same time everyday.
- Get dressed even if you don't need to, it helps your brain switch from chill to work mode.
- Create an exercise routine outside, we are lucky that we have excellent weather during the fall. Start your day with a walk or end your day with a workout.
- All of the assignments, quizzes and exams will open and close at the same time to keep you on a schedule.
- Put all coursework into a calendar. Your phone calendar. Your Google calendar. A paper calendar. Put all the deadlines in the calendar and it will you stay on track.

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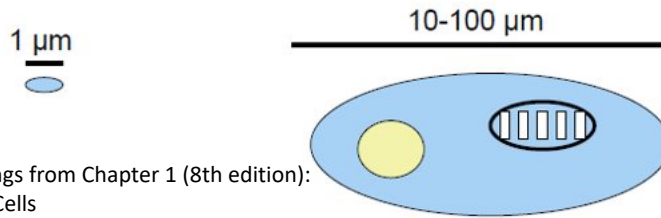
Strategies for success

1. In the process of developing an understanding of cells, every lecture is a building block for the next; missing even one lecture will weaken your understanding for the rest of the semester.
2. Take notes. You 'learn through your hands'. Yes, I want you to take notes on my pre-recorded lectures
3. Read the text and other supplementary material.
4. Do the review questions! Do the review questions! I use these when I write the exams!
5. Enjoy the course! Even through this can be a difficult course, it is amazing how cells work. Every once and a while stop and be amazed.

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Lecture 1: Introduction to cell biology

1. An introduction and a bit of history
2. Basic properties of cells
3. Prokaryotes vs Eukaryotes
4. The size of cells and their components



Suggested Readings from Chapter 1 (8th edition):

- 1.1 Discovery of Cells
- 1.2 Basic Properties of Cells
- 1.3 Two Classes of Cells
- Sizes of Cells & Components

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Cells are the smallest unit of life

A cell is defined as – a self-contained membrane-bound unit which can perform the functions of life.

Organized
Autonomous
Internally regulated

Cell biology is **reductionist**

Knowledge of parts may explain the whole unit
May be viewed as a machine but many components still unknown or not understood

Understanding cell function can be directly applied to the nature of life

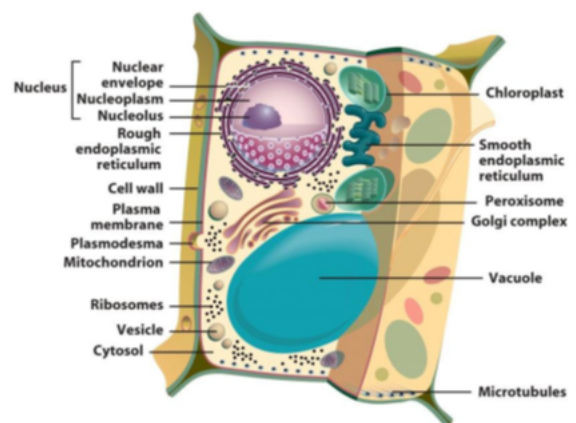


Figure 1-4b: Cell and Molecular Biology, 4/e (© 2005 John Wiley & Sons)

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Cells were discovered as a direct result of the development of microscopes

Robert Hooke (1665) – observed cork

- Empty, dead cells
- Cell wall remained

Anton van Leeuwenhoek (1665-1675)

- First observation of living cells
- Vorticella – an “animalcule”, small single cell organisms

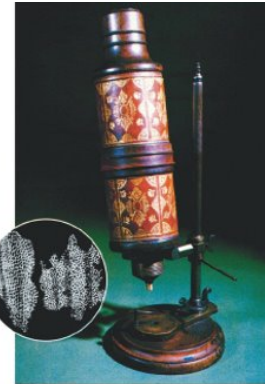


Figure 1-1a Cell and Molecular Biology, 4/e (© 2005 John Wiley & Sons)



Vorticella – an “animalcule”



Figure 1-1b Cell and Molecular Biology, 4/e (© 2005 John Wiley & Sons)

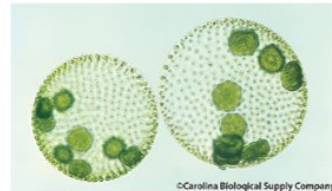
Hand-held microscope

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Tenets of cell theory

- Theodor Schwann (1839) - first 2 tenets of cell theory:
 - All organisms composed of one or more cells
 - Cells are the structural unit of life
- Rudolf Virchow (1855) - third tenet
 - Cells can arise only by division from preexisting cells

Volvox – a simple multicellular organism



©Carolina Biological Supply Company
(Courtesy of Carolina Biological Supply Company)

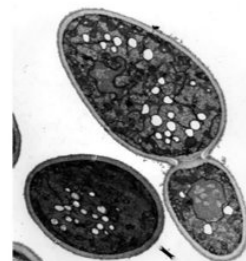
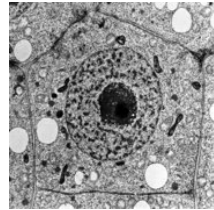


Figure 1-1b Cell and Molecular Biology, 4/e (© 2005 John Wiley & Sons)

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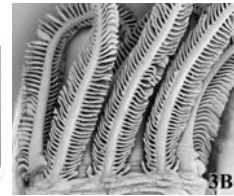
Various instruments are used to observe cells

Transmission Electron Microscope



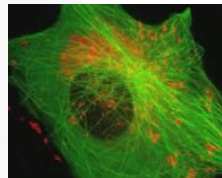
TEM of root cell

Scanning Electron Microscope



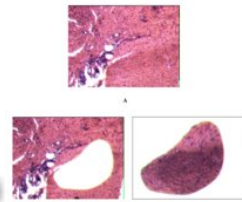
SEM of fish gill

Confocal Scanning Laser Microscope



CLSM of human cell

Laser Capture Microdissection Scope



LCM of tumor cells

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Cell biology is a multidisciplinary study of cell structure and function

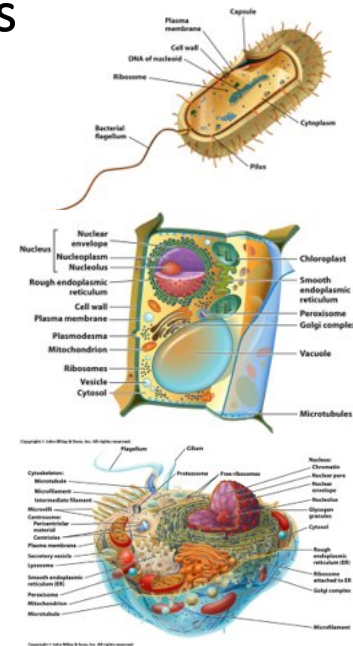
Cell Biology includes a number of other scientific disciplines including:

- Histology / anatomy
- Genetics
- Biochemistry
- Physiology
- Ecology
- Molecular biology
- Virology
- Immunology
- Development
- Computational biology / bioinformatics
- Synthetic biology

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Cells have two basic properties

- **Life is the most basic property of cells.**
 - They are the smallest units to exhibit the property of life
 - Cells can be removed from an organism and cultured in the laboratory
- **Cells are highly complex and organized**
 - Cellular processes are highly regulated.
 - Cells from different species share similar structure, composition and metabolic features that have been conserved throughout evolution.



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Basic properties of cells

- **Cells have a genetic program and the ability to use it**
 - Genes encode information to build each cell, and the organism.
 - Genes encode information for cellular reproduction, activity, and structure.
- **Cells are capable of producing more cells**
 - Cells reproduce, and each daughter cells receives a complete set of genetic instructions.
- **Cells acquire and utilize energy**
 - Photosynthesis provides fuel for all living organisms.
 - Animal cells derive energy from the products of photosynthesis, mainly in the form of glucose.
 - Cell can convert glucose into ATP— a substance with readily available energy.



Cell division

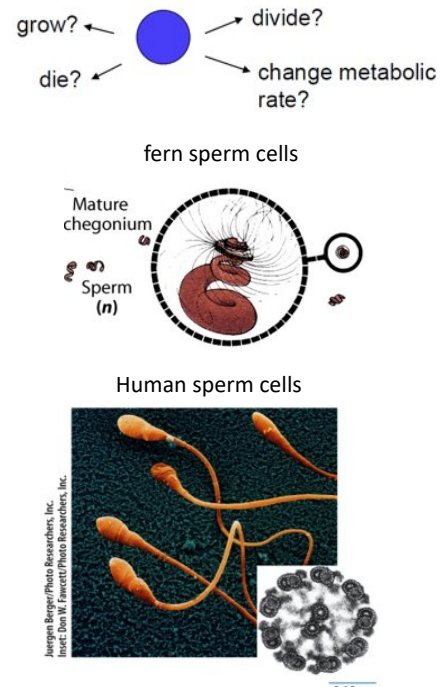


alga can photosynthesize!

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Basic properties of cells

- **Cells Carry Out a Variety of Chemical Reactions**
 - Catalyzed by enzymes
- **Cells Engage in Mechanical Activities**
 - Structures assembled and disassembled
 - Cytoskeleton and organelle movement
- **Cells Are Able to Respond to Stimuli**
 - Receptors that sense environment & initiate responses.
- **Cells Are Capable of Self-Regulation**
 - The information for cellular regulation reside in nucleic acids and other proteins
- **Cells Evolve**
 - Evolution is not simply an event of the past, but an ongoing process that continues to modify cell properties that will be present in organisms yet to appear



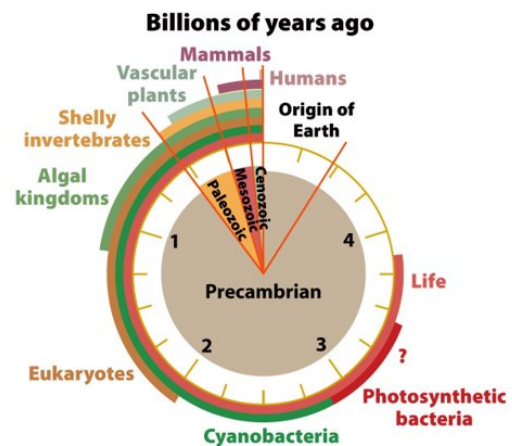
25

There are two fundamental classes of cells

Prokaryotic and *Eukaryotic* cells are distinguished by their size and type of organelles.

Prokaryotes are all bacteria, which arose ~3.7 billion years ago.

Eukaryotes include protists, animals, plants and fungi.



Earth's biogeological clock
Origin of life is still speculative

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Comparison of Prokaryotic and Eukaryotic Cells

TABLE 1.1 A Comparison of Prokaryotic and Eukaryotic Cells

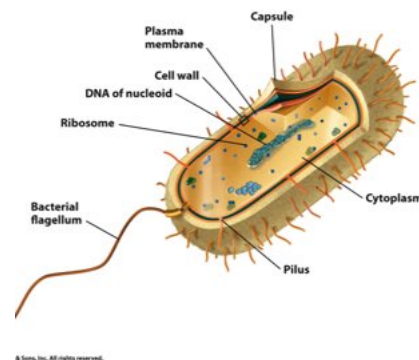
Features held in common by the two types of cells:

- Plasma membrane of similar construction
- Genetic information encoded in DNA using identical genetic code
- Similar mechanisms for transcription and translation of genetic information, including similar ribosomes
- Shared metabolic pathways (e.g., glycolysis and TCA cycle)
- Similar apparatus for conservation of chemical energy as ATP (located in the plasma membrane of prokaryotes and the mitochondrial membrane of eukaryotes)
- Similar mechanism of photosynthesis (between cyanobacteria and green plants)
- Similar mechanism for synthesizing and inserting membrane proteins
- Proteasomes (protein digesting structures) of similar construction (between archaeobacteria and eukaryotes)

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Prokaryotes are defined by the following characteristics

- 1-10 μm (recently, rare exceptions have been found)
- DNA is free in the cytoplasm
- DNA is not associated with DNA-condensing proteins
- Include bacteria and archaea (extremophiles)

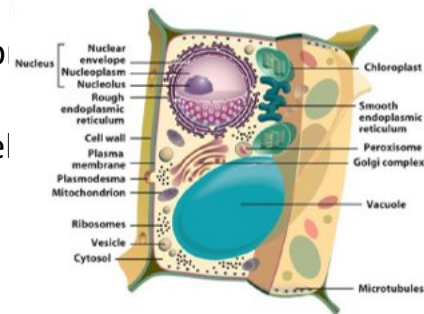


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Eukaryotes are defined by the following characteristics

- (eu=true, karyon=nucleus)
- Membrane-bound nucleus; more DNA than prokaryotes
- Typically 10-100 μm in diameter
- Eukaryotic cells have organelles (eg. Mitochondria, endoplasmic reticulum, Golgi, etc.)
- Eukaryotic cells divide by mitosis/meiosis, p divide by binary fission)
- Eukaryotic cells have more complex cytoskeleton motility machinery than prokaryotes

Protists, fungi, plants and animals!!!!

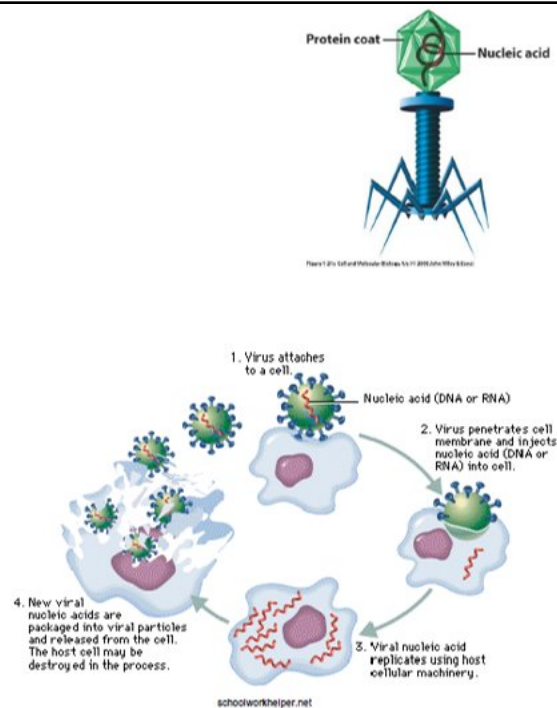


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Viruses are not cells

- **Viruses** – crossroads
Between living and non-living matter:
 - reproduce only in cells
 - inert outside the cells
 - viruses are bits of nucleic acids that have a protein coat
- **Viroids** – circular RNA without protein coat
- **Prions** – proteinaceous infectious particles

Are these life forms?



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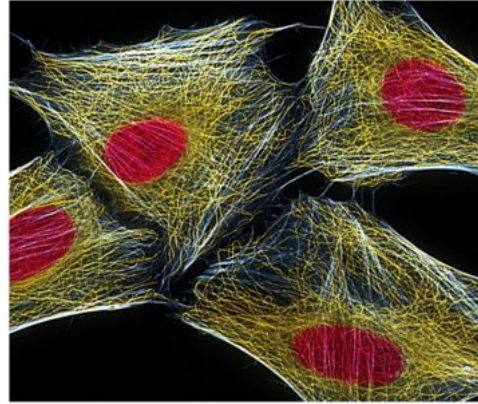
Cell biology uses cell cultures and model organisms

Cell cultures are either:

- 1.) cancer cells
 - in 1951 George Grey made the first human cell cultures from a tumor removed from **Henrietta Lacks**
- 2.) 'normal' cells taken from an organism
 - these must be given specific factors to grow and have a limited lifespan
 - e.g. tobacco BY-2 cells

Why cell culture?

- 1.) easy to give cell cultures drugs or other treatments and see how they respond.
- 2.) simpler system than studying cells in whole tissues and/or organisms.



HeLa cells were the first cells to be kept for long periods in culture and can be cultured indefinitely... we're still using them!

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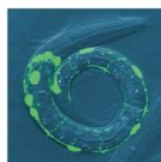
Cell biology uses cell cultures and model organisms

Model organisms are used because they're easy to manipulate and easy isolate mutants that have 'broken' genes

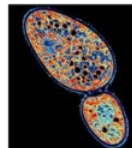
- *E. coli* (a prokaryote) – our first understanding of DNA replication, transcription, translation
- *Saccharomyces cerevisiae* – simplest eukaryote, many mutants
- *Arabidopsis thaliana* – fast growing plant, small genome, many mutants
- *Caenorhabditis elegans* – ~ 1000 cells, short life cycle
- *Drosophila melanogaster* – 1000s of mutants, best characterized genome
- *Mus musculus* – 1000s of mutants, easiest mammal for genetics studies



E. coli



C. elegans



Saccharomyces



Drosophila



Arabidopsis



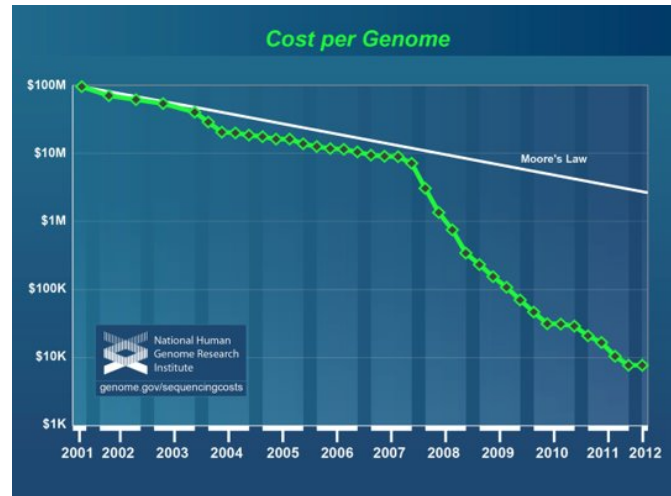
Mus musculus

Using next generation sequencing technologies, this number has increased dramatically!!

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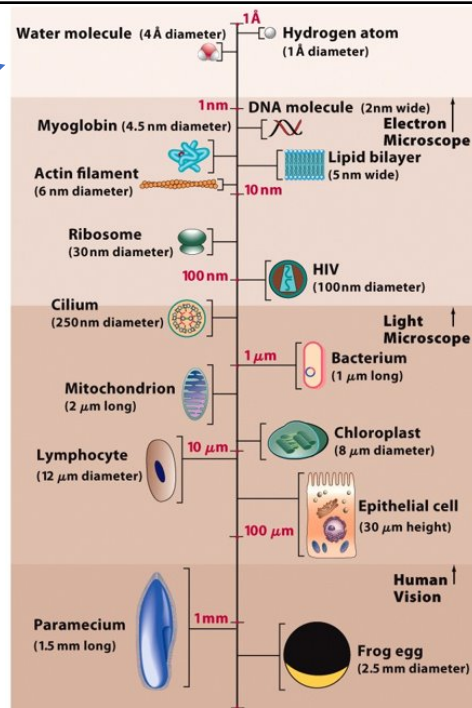
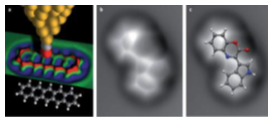
The cost of sequencing genomes is coming down!

- The cost of sequencing genomes is dropping!
- Size of Human Genome = 3.3×10^9 bp
- We can now sequence an entire human genome in about a day and for less than \$10,000 (compare to \$3 billion for the first!)
- \$1,000 Human Genome coming soon!
- Personalized medicine.



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Relative sizes of cells and components



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Cells are small for the following reasons

To maintain a proper surface area/volume ratio

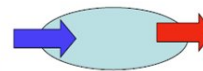
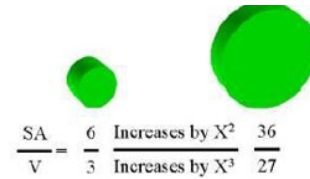
– as cell size increases, surface area/volume decreases

- $A=4\pi r^2$ $V=4/3\pi r^3$
- If surface area drops, difficult to take up nutrients and rid wastes

– Large celled exceptions:

- Adsorptive epithelium – microvilli
For adsorption
- Eggs – small amount of protoplasm on big yolk
- Nerve cells – long length, narrow width

Cells depend on diffusion to move substances – large cells unable to diffuse quickly



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You should know the following things about cells

- How to define a living cell
- Key scientists, approximate dates, and contributions to cell theory
- Differences between eukaryotic and prokaryotic cells
- Why viruses are not considered living?
- Why are cells small?

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