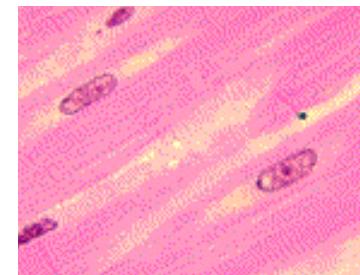
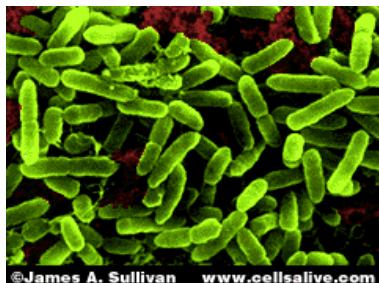


Bioscience & Bioengineering 101: BB101

Welcome to BB101!

This is a unique course curriculum in which you are getting a broad flavor of biology. You would have to take 5-6 courses in our department to get this breadth.



Bioscience & Bioengineering 101: Instructors

Molecular & Cellular Biology: Rahul Purwar

Office: Room 302

Biosciences & Bioengineering

purwarrahul@iitb.ac.in

Phone: 7737

Physical Biology: Ambarish Kunwar

Office: Room 204

Biosciences & Bioengineering

akunwar@iitb.ac.in

Phone: 7799

Biomedical Engineering: Rohit Srivastava

Office: Room 505

Biosciences & Bioengineering

rsrivastava@iitb.ac.in

Phone: 7746

Bioscience & Bioengineering 101: Schedules Fall 2014

Morning D1 batch (slot 6A, 6B): Lectures: Wednesday and Friday: 11:05am to 12:30pm
Tutorials: Tuesday 11:35am-12:30pm

Afternoon D3 batch (slot 11A, 11B): Lectures: Tuesday and Friday; 3:30pm to 4:55pm
Tutorials: Wednesday; 4:00pm-4:55pm

-Venues

- Lectures for ALL: LA101
- Tutorials: LT301, 302, 303, 202, 203

Molecular and Cellular Biology: 06 January to 03 February
Quiz: Date will be announced soon!

Physical Biology: 06 February to 17 March
Quiz: Date will be announced soon!

Biomedical Engineering: 20 March to 17 April
Quiz: Date will be announced soon!

Mid sem exam and end sem exam: institute timetable

Bioscience & Bioengineering 101

Structure of the course (for each division)

Every week:

One hour lectures (in 1 and ½ hour slot) (2)

Tutorial (1)

Home work (only Akun)

**Quizzes (3): 9 marks (Rpur) and 8 marks each of RS and AkunTotal
25 marks**

Mid sem exam: 25 marks (RPur)

End sem exam: 50 marks (AK, RS; 25 marks each)

Attendance: Absolutely essential, not least because the exams will be based on topics we discuss during lectures, tutorials and HW.

If you get <30%, you will get a FAIL grade!

Know your TAs! Molecular and Cellular Biology

Sr. No.	Name	Gmail Id (@gmail.com)
1	Siddhartha Das	drsiddharthadas82
2	Kamini Gautam	kaminigautam1
3	Reema Bajaj	reema21m
4	Farha Memon	farhamemony2012
5	Supriya	supriya.bio02
6	Sathya Srinivasan	sathyasrini.91
7	Asha Densi	ashadensi@gmail.com
8	Sandip Singh Patel	sandipsinghpatel
9	Pragati Anand Mastud	pragati114

Know your TAs! Biomedical engineering

133300007	Samrat	BTech Biomedical	BB101 (RS)
133300008	RichiSethi	B.E. Biotechnology	BB101 (RS)
133300010	Shrikrishna V Dongre	BE Biotech	BB101 (RS)
11I300008	Ashish Jha	M.Sc. Ph.d Dual	BB101 (RS)
134300002	Mastud Pragati Anand	M.Sc (MB)	BB101 (RS)
144303004	Mukti Vats	MPHARM (PY)	BB101 (RS)
11I300007	Mukesh Dhanka	M.Sc. Ph.d Dual	BB101 (RS)
134303002	Nishant Jain	M.S. Pharm (PY)	BB101 (RS)
134300003	Nilapratim Sengupta	M.Tech BME	BB 101 (RS)

Tutorials & TAs

Tutorials & TAs					
Tuesday (1135-1230)	LT 301 (Tutorial 1) Siddhartha/ Kamini	LT302 (Tutorial 2) Sathya/Asha	LT303 (Tutorial 3) Farha/ Supriya	LT202 (Tutorial 4) Reema/ Sandeep	LT203 (Tutorial 5) Pragati
Wednesday (4-455)	LT 301 (Tutorial 1) Siddhartha/ Kamini	LT302 (Tutorial 2) Sathya/Asha	LT303 (Tutorial 3) Farha/ Supriya	LT202 (Tutorial 4) Reema/ Sandeep	LT203 (Tutorial 5) Pragati

Introduction to Molecular and Cell Biology

Molecular and Cellular Biology

Lecture 1

Rahul Purwar

purwarrahul@iitb.ac.in

Room # 302, Biosciences and Bioengineering

Text/References

Campbell Biology

Reece, Urry, Cain, Wasserman, Minorsky, Jackson
9th Edition, Cummings

Biology is Science

- ❖ Biology has laws, rules and principles
- ❖ Molecular and genetic principles
 - DNA, proteins, lipids, etc
 - Heredity
 - Utilization of energy
- ❖ Some aspects of evolution-Unity and diversity

Although you may have ‘mugged’ biology, this course will show you it is as logical as other science subjects

Biology is the study of life

- **The phenomenon we call life:** defies a simple, one-sentence definition

The condition that distinguishes organisms from inorganic objects and dead organisms, being manifested by growth through metabolism, reproduction, and the power of adaptation to environment through changes originating internally-*From Dictionary.com*

Why study ‘life’ ?

Basis of many things that happen to us today: diabetes, heart attacks, drug/cigarette addiction, etc, etc.

Biology is the future: personalized medicine, genetically modified crops, etc, etc.

It is nice to know enough to make informed decisions for ourselves.

Objectives of this section of the course

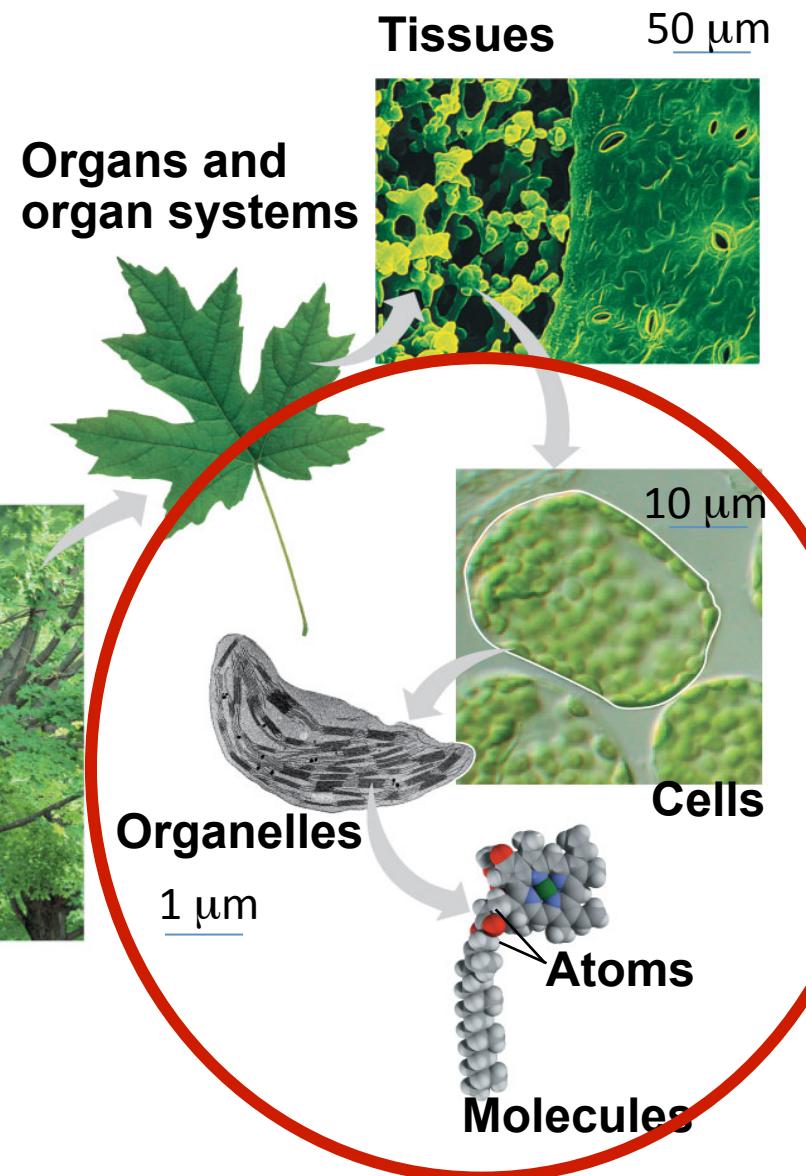
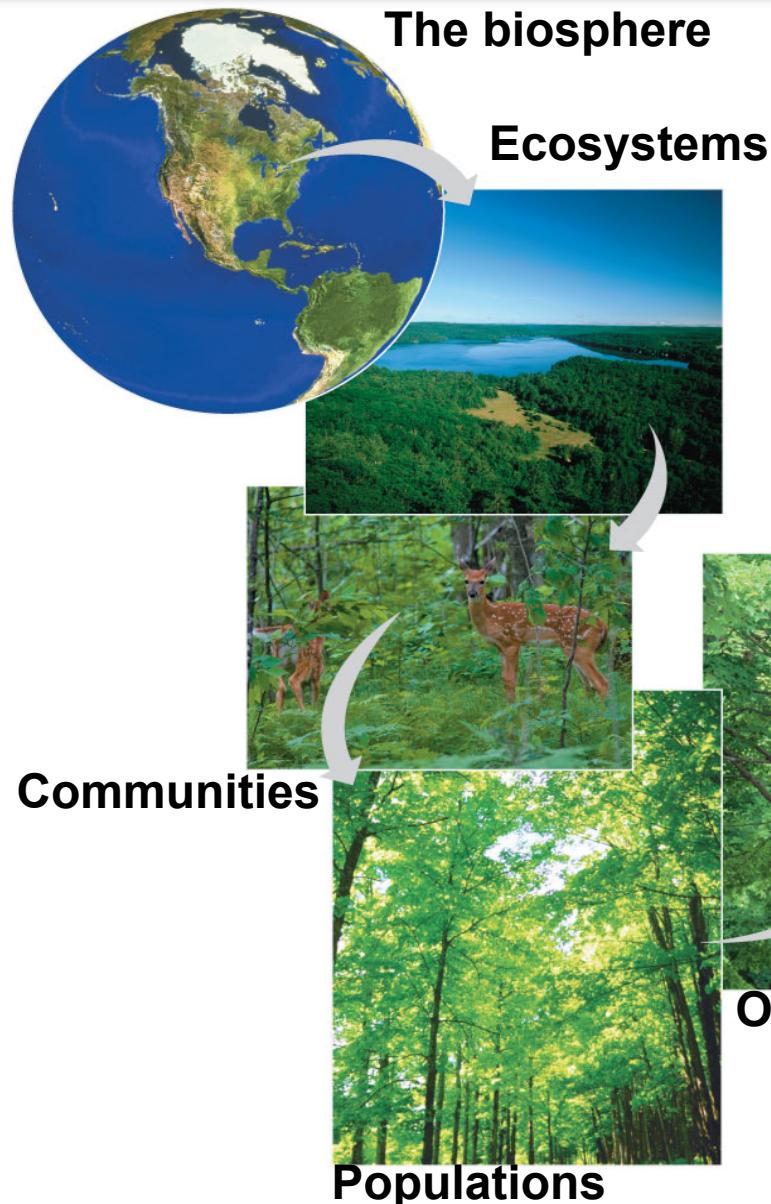
90% of you

- Give most of you enough biology background so that you have a decent understanding as you move ahead in life
 - WHY? Today and tomorrow's world is one where advances in biology will affect you every day: going to the hospital, deciding whether to buy GM brinjal, etc.
 - We will use these futuristic scenarios in every class and tutorial

10% of you

- Convey to some of you the excitement of biology
 - WHY? You can use your engineering background to contribute to biology and biomedical research

A Hierarchy of Biological Organization



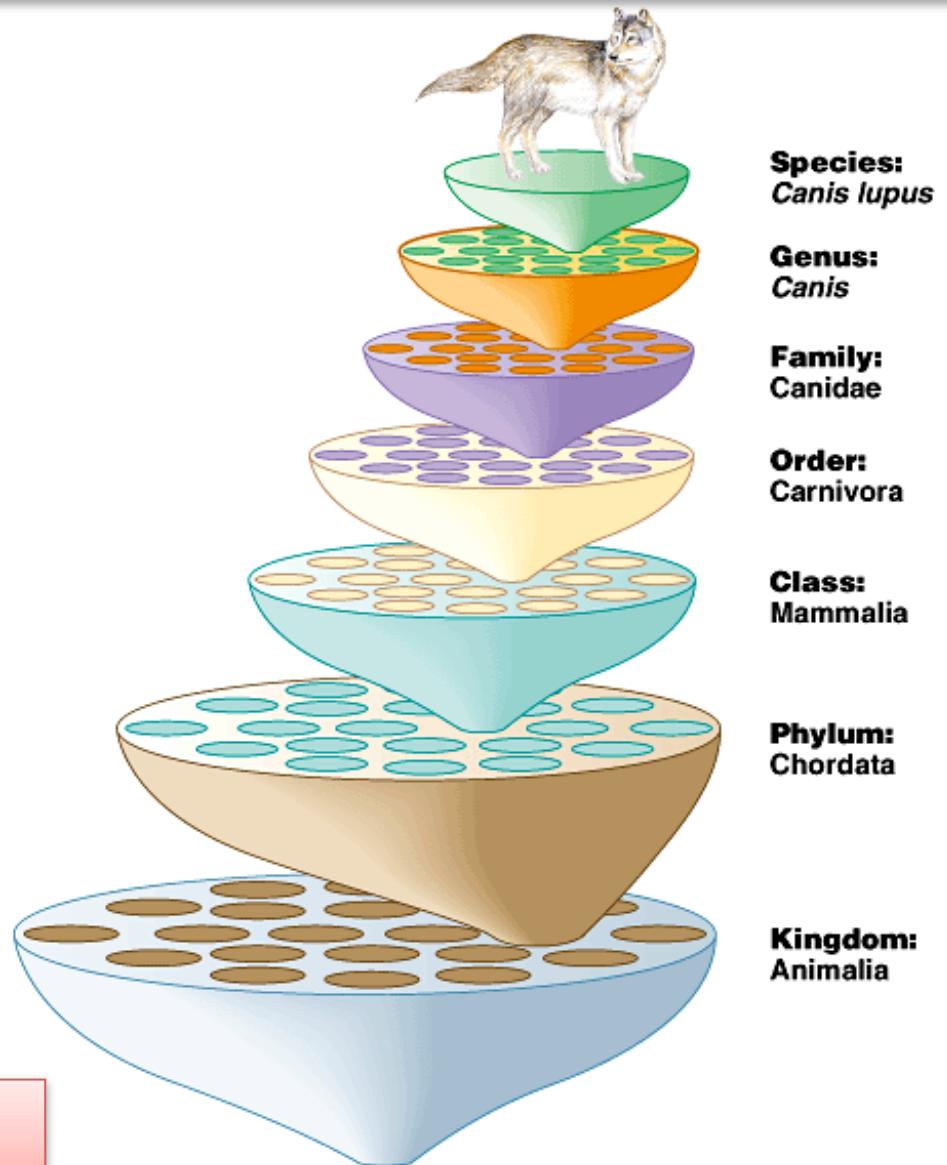
Diversity is a hallmark of life

- 5 to over 30 million species
- 1.5 million species have been named
 - This includes over 280,000 plants, almost 50,000 vertebrates, and over 750,000 insects.

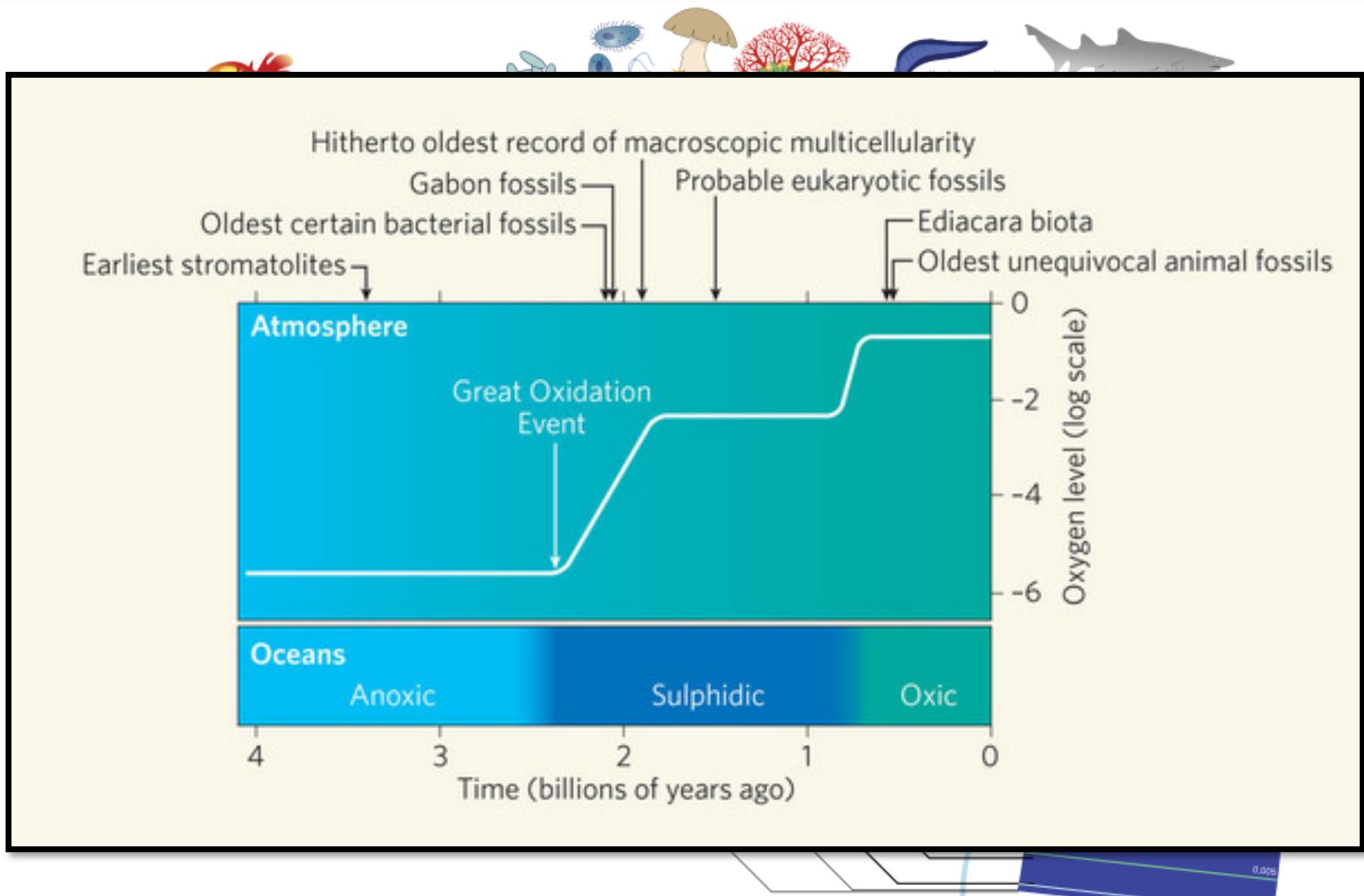
Taxonomy

- In the face of this complexity, humans are inclined to categorize diverse items into a smaller number of groups!
- Taxonomy is the branch of biology that names and classifies species into a hierarchical order
- Also helps to think about evolution

Is this why you hated Biology?



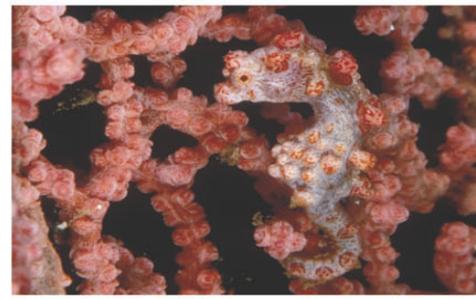
History of life



Some basic characteristics of life



(a) Order



(b) Evolutionary adaptation



(c) Response to the environment



(d) Regulation



(e) Energy processing



(g) Reproduction



(f) Growth and development

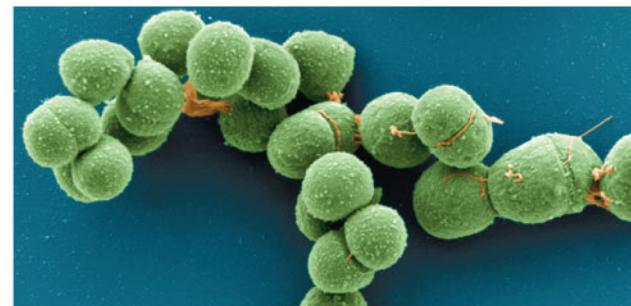
Homeostasis
Regulation of internal environment
Constant conditions maintained
Examples: body temperature, etc

The three domains of life

Bacteria



Archaea



Eukarya



▲ Kingdom Plantae



► Kingdom Fungi



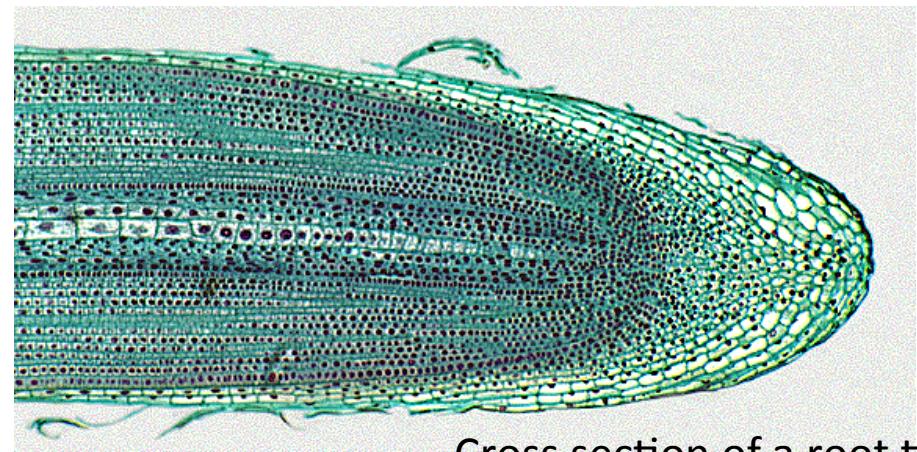
► Protists



100 μm

The Cellular Level of Organization

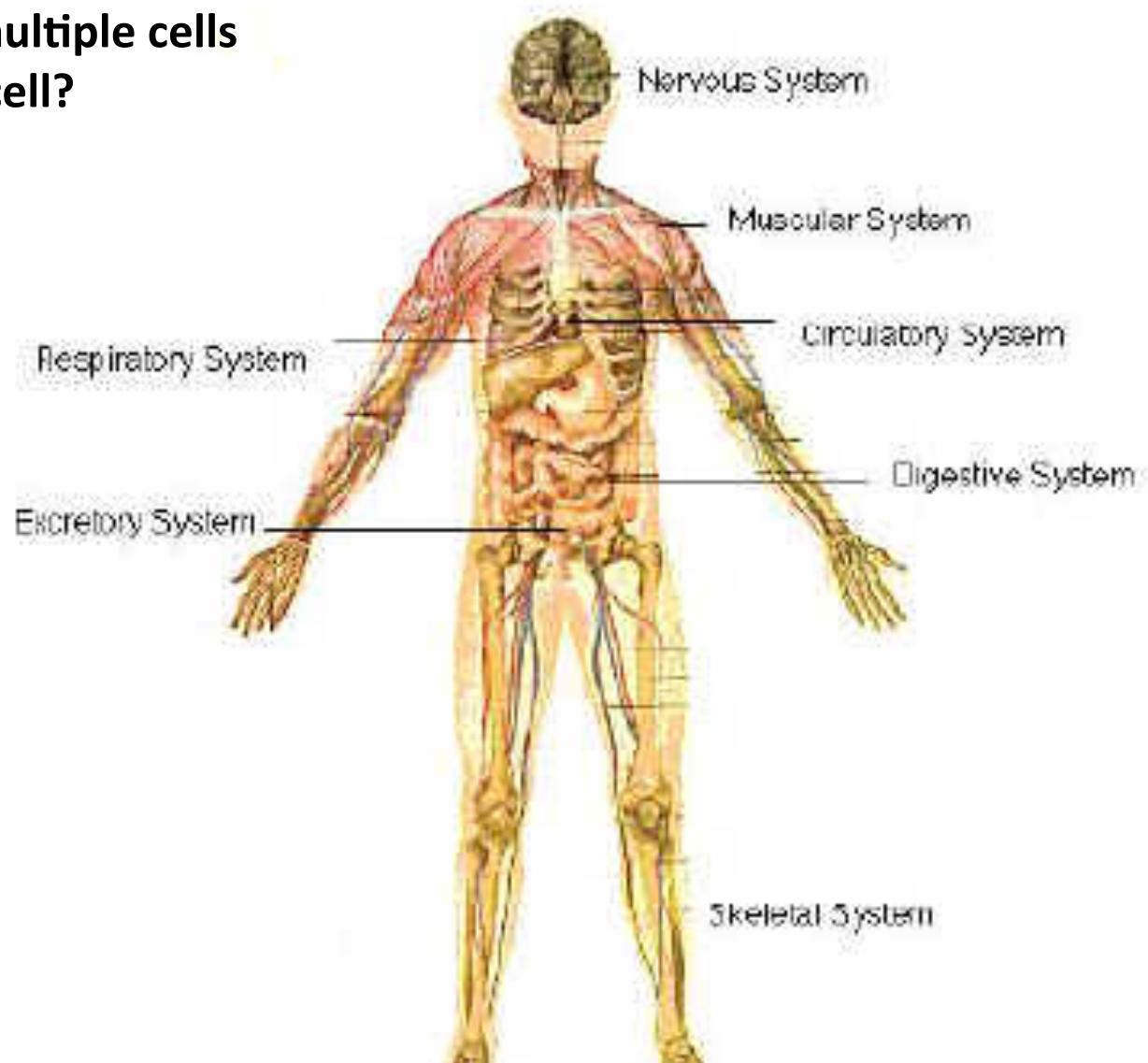
- ❖ Like a building is constructed of bricks, living things are constructed of *cells*.
- ❖ Living things may be *unicellular* or *multicellular*.
- ❖ Therefore, a cell can be classified as the smallest ‘unit’ of life.
- ❖ Simple microscopes resulted in the discovery of cells.



Cross section of a root tip

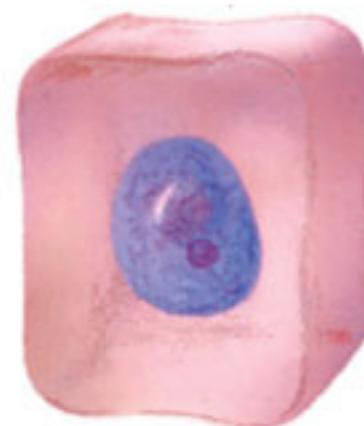
Organs, tissues, & cells: Structure-function relationship

Why are we made up of multiple cells instead of one very large cell?



Natural laws limit cell size

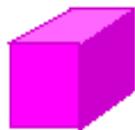
- ❖ At a minimum, a cell must contain enough volume to house the parts it needs to survive and reproduce
- ❖ The maximum size of a cell is limited by the amount of surface area needed to obtain nutrients from the environment and dispose of wastes
- ❖ Surface area relative to the volume decreases as size of cell increases.
 - limits the size of cells



There are several ways to improve the SA:V ratio and multi-cellularity is one such way

Surface area of a cuboid:

$$SA = 2(lw + wh + hl)$$

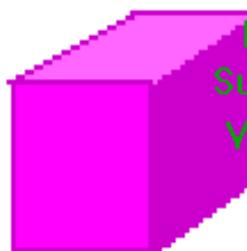


Length = 1mm
Surface area = 6mm^2
Volume = 1mm^3

$$\text{SA:V} = 6$$

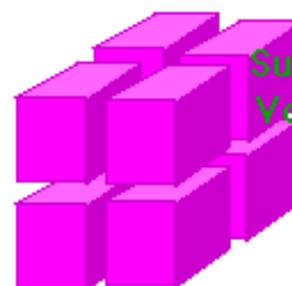
Volume of cuboid:

$$V = lwh$$



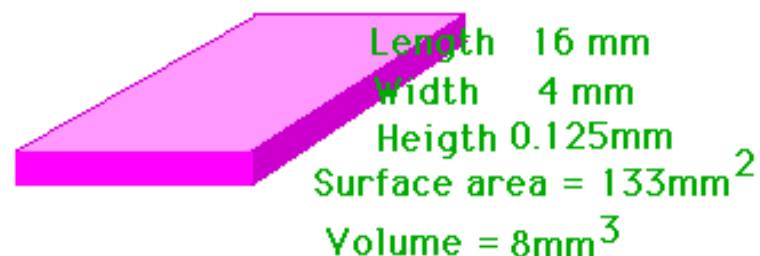
Length = 2mm
Surface area = 24mm^2
Volume = 8mm^3

$$\text{SA:V} = 3$$



Surface area = 48mm^2
Volume 8mm^3

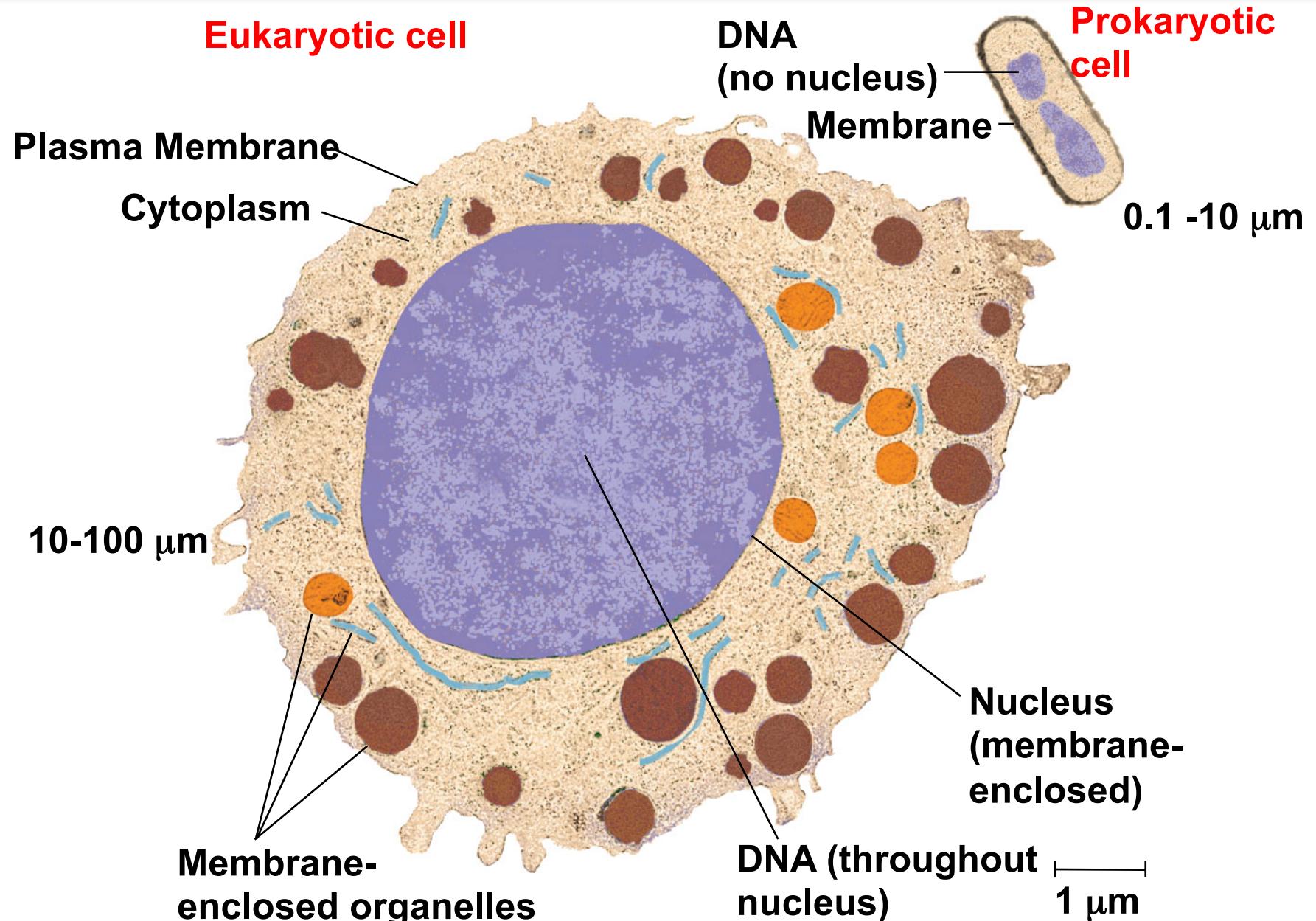
$$\text{SA:V} = 6$$



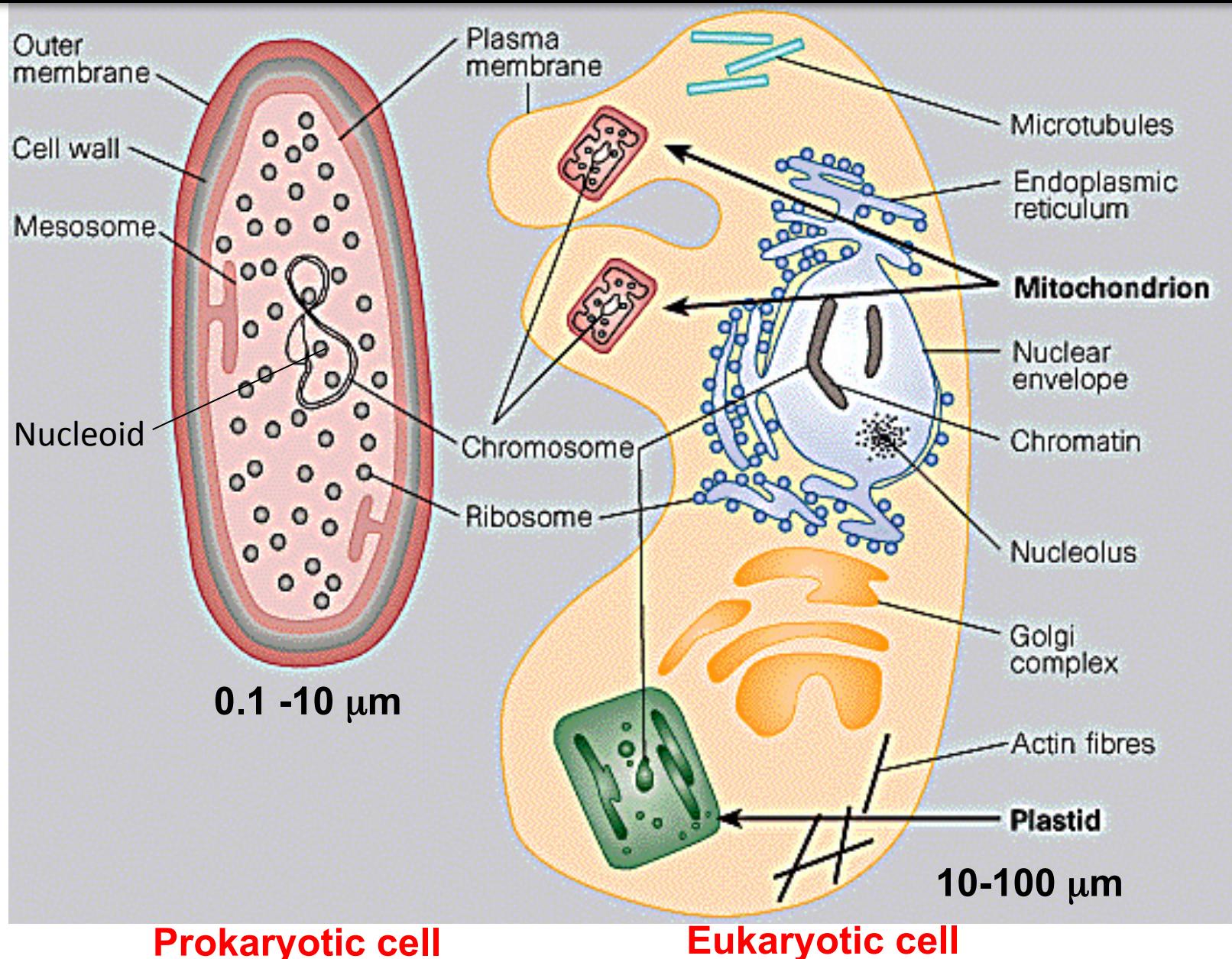
Length 16 mm
Width 4 mm
Height 0.125mm
Surface area = 133mm^2
Volume = 8mm^3

$$\text{SA:V} = 16.625$$

Eukaryotic cells are compartmentalized



Prokaryotic vs eukaryotic cells



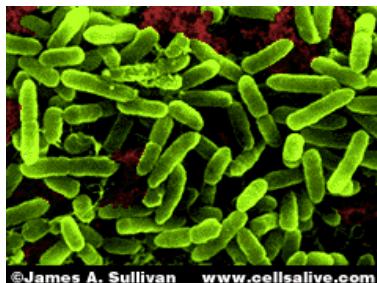
There are only 2 successful cellular plans of organization

Eukaryotes (true nucleus)

- cell plan of multi-cellular organisms

Prokaryotes (before nucleus)

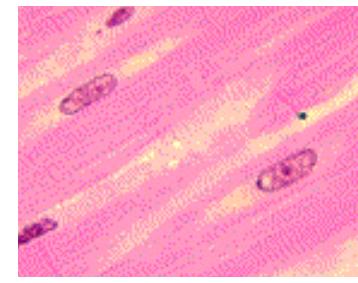
- primitive, simple, versatile, ubiquitous, unicellular life form
- a most successful life form- 80% to 90% of total biomass of planet
- 2,500 different species known



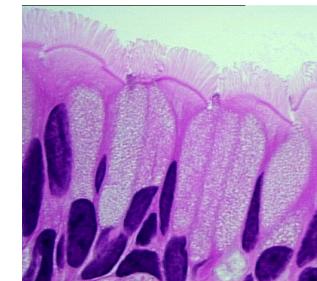
Common soil bacteria
Pseudomonas aeruginosa



Human red blood cells



Monkey heart muscle



Amphibian
esophagus cells

Eukaryotic cells are compartmentalized

Kitchen
(preparation of food)

Living room
(relaxation)

Toilets
(cleaning)



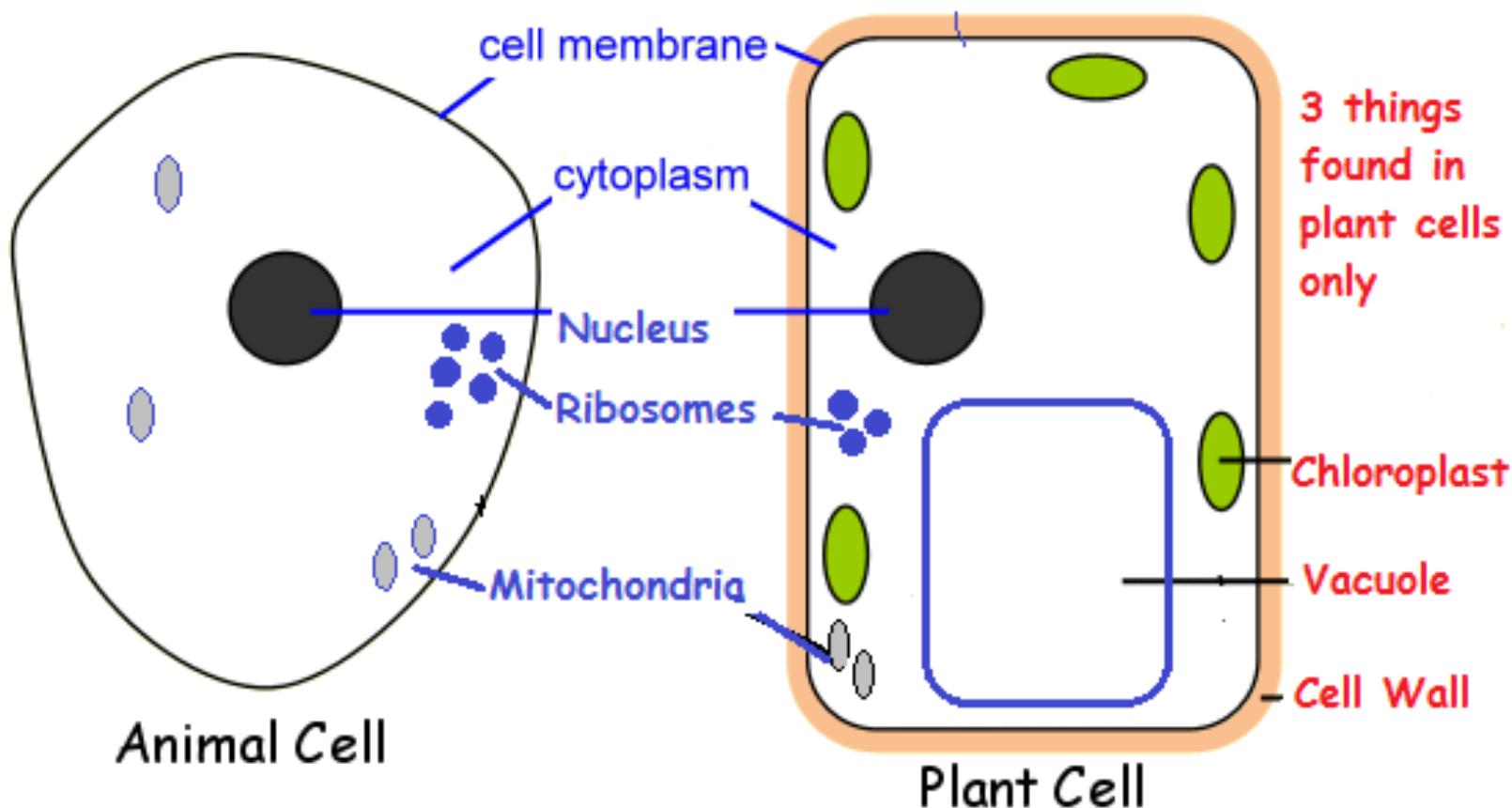
Windows
(ventilation)

Door (entry/exit)

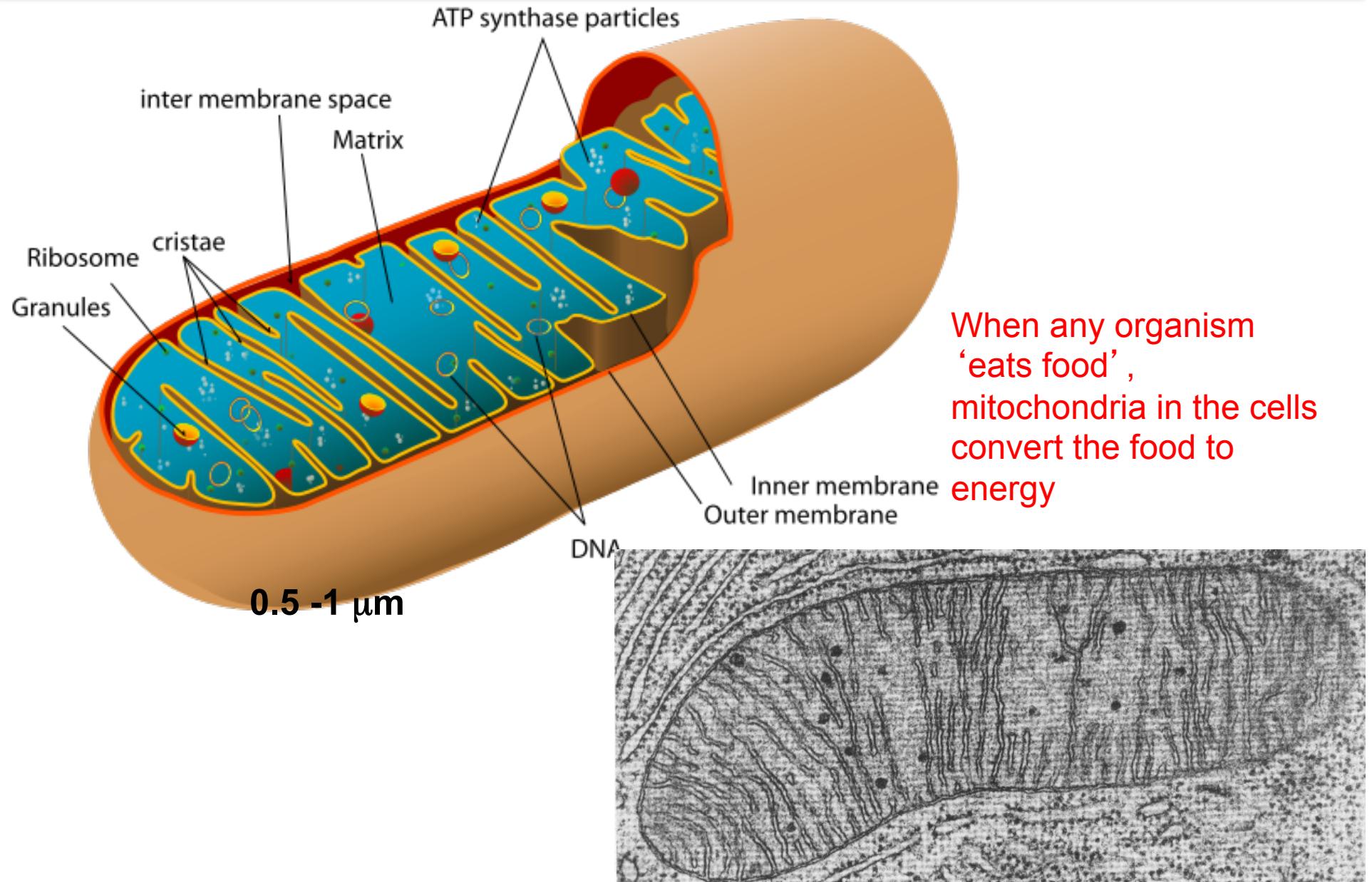
Animal and plant cells have *organelles (little organs)*.

Organelles *compartmentalize functions* within the cell.

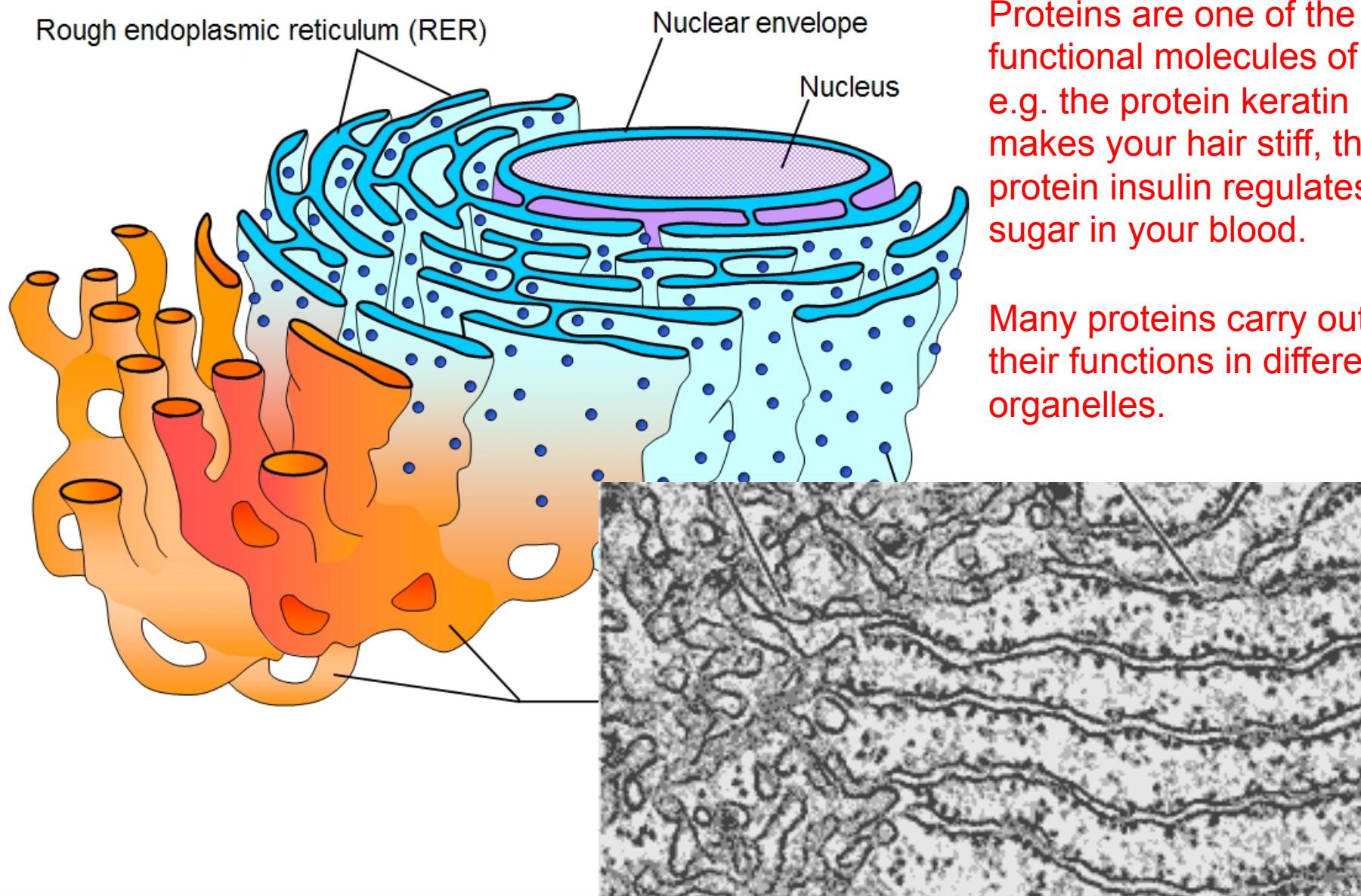
Animal vs plant cells



Mitochondria generate energy



Endoplasmic Reticulum synthesizes proteins



Proteins are one of the functional molecules of life
e.g. the protein keratin makes your hair stiff, the protein insulin regulates sugar in your blood.

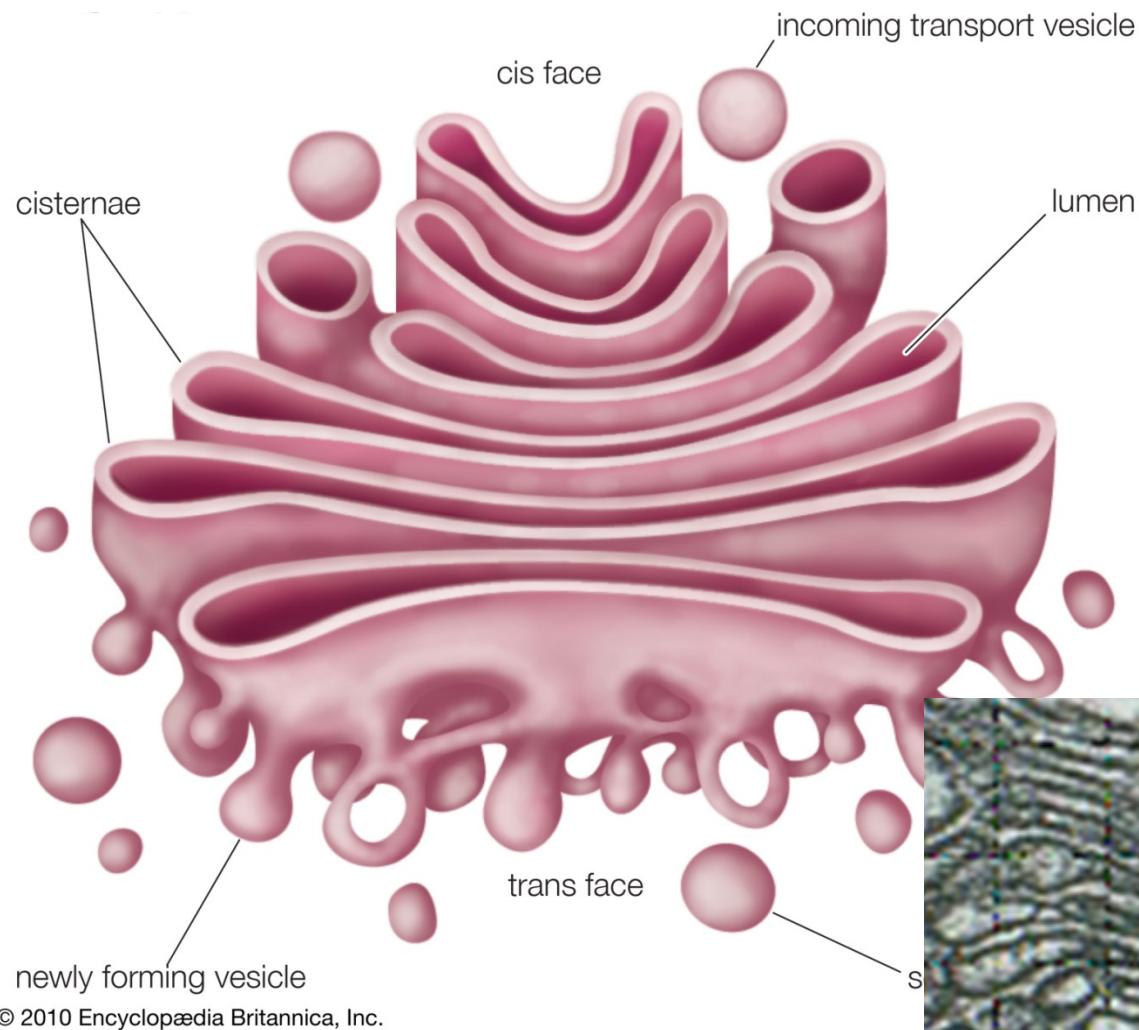
Many proteins carry out their functions in different organelles.

How do proteins get to the right location in a cell?

ER has its own Molecular FedEx system!

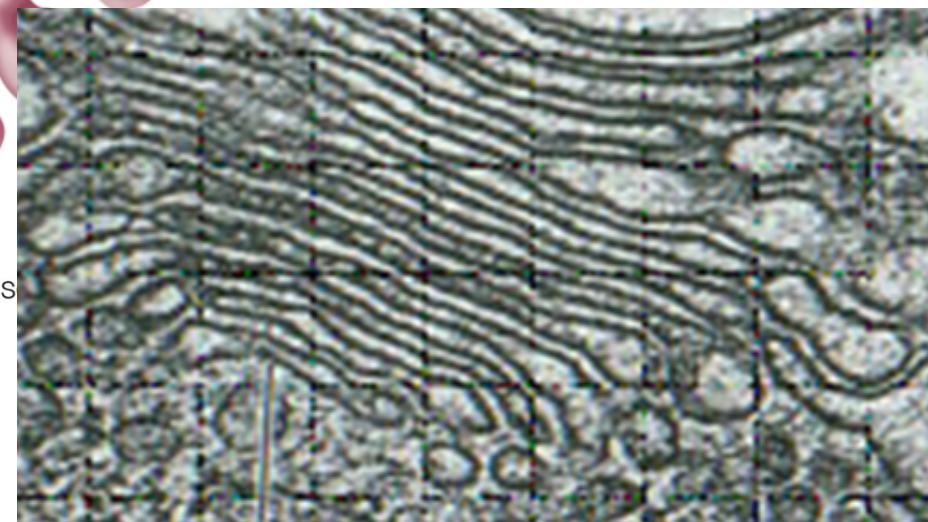


Golgi Apparatus sorts the proteins for their destinations

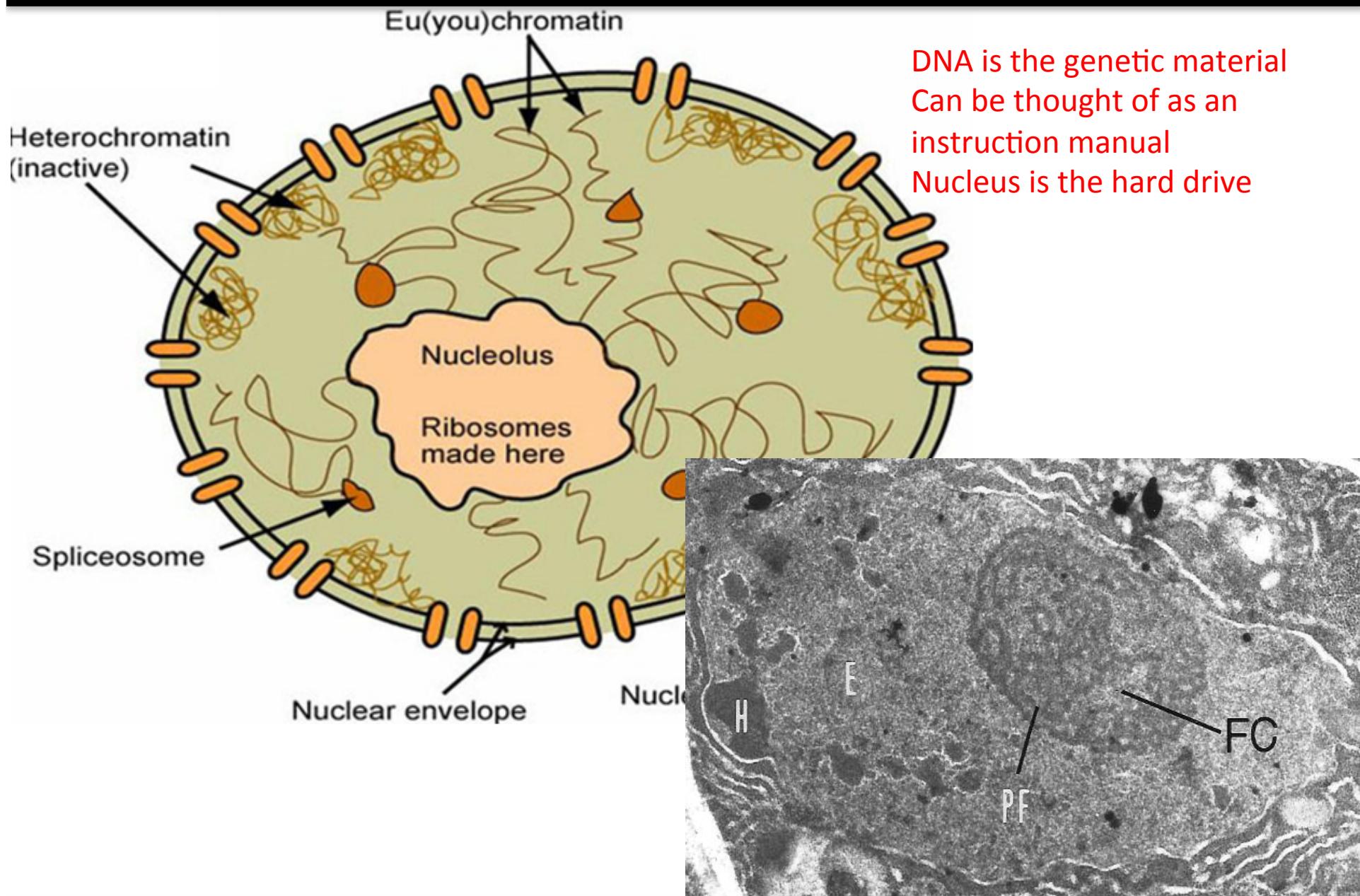


Exocytosis: sending proteins outside the cell

Golgi is like a Post Office



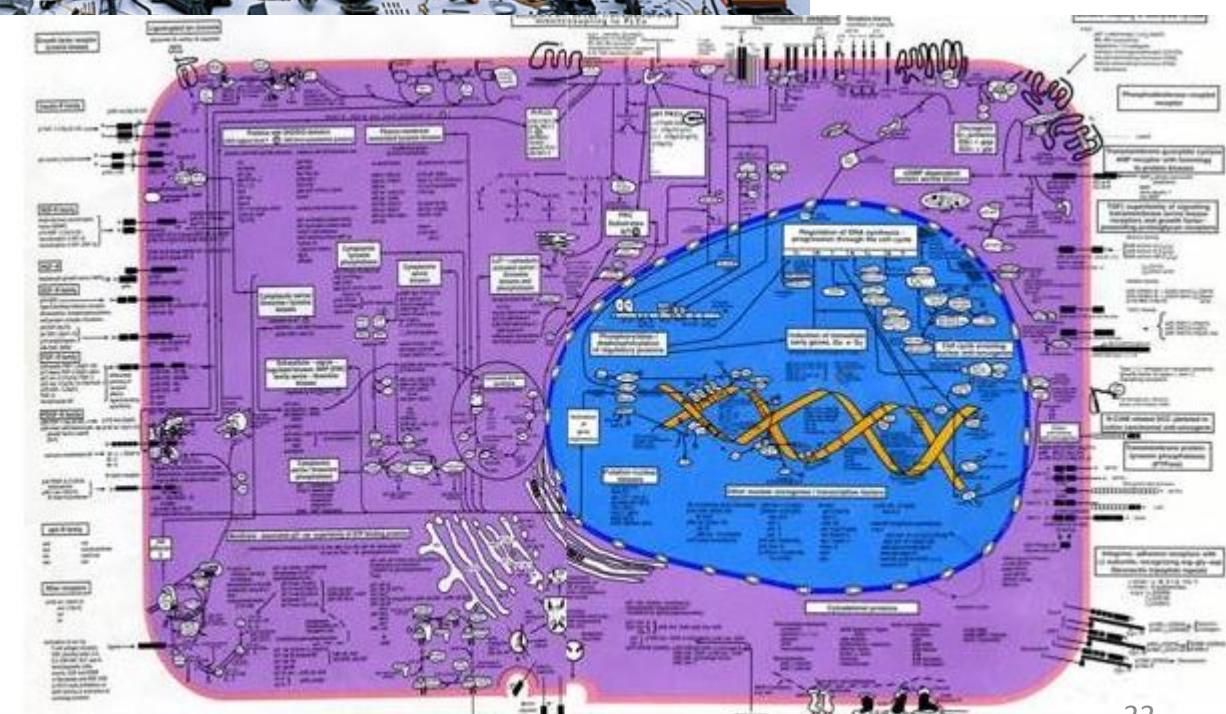
Nucleus contains the DNA



Other Organelles needed for proper functioning of the cell

- **Plasma membrane:** the outer membrane of the cell that protects and shapes the cell
- **Cytoskeleton system:** helps to maintain the rigidity and shape of the cell
- **Molecular motors:** certain proteins that work along with the cytoskeleton and help in cell movement
- **Flagella:** seen in bacteria. The cell's own biochemical turbine jet propulsion system!

Parts of cell and parts of an automobile engine



Take home message

- **Time table schedule:** Keep your time table handy and attend all the classes of all three modules.
- **Biology** is a logical subject with laws, rules and principals.
- **Taxonomy** is the branch of biology that names and classifies species into a hierarchical order
- **Basic characteristics of Life:** Order (not random), evolutionary adaptation, responses to the environment, energy processing, regulation (Homeostasis), reproduction, growth & development.
- **Structure-function relationship:** Cell is compartmentalized and each organelle has unique function.

Why study biology? It's fun and full of un-answered questions!



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VIVEK JAYARAMAN

Lab Head

[Jayaraman Lab](#)

[Contact Me](#)

Vivek studied to be an aerospace engineer, and spent a few fun years developing numerical simulation software for The MathWorks. A couple of excellent neuroscience courses at Brandeis University convinced him to study brains instead. He now spends his time trying to understand bugs that are a bit more fun to work on than the ones he encountered in his previous career.

B.Tech., Indian Institute of Technology, Bombay (1994)

MS, University of Florida, Gainesville (1996)

PhD, California Institute of Technology, Pasadena (2006)



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Lab
Members

Publications

Joining the
Lab

Lab News

Contact Us



Malik Lab Members

Dr. Harmit Malik

Harmit Malik grew up in the city of Bombay (now renamed Mumbai) in India. He attended the Indian Institute of Technology where he received a degree in Chemical Engineering. There, he was introduced to molecular biology thanks largely to the generous mentoring of Dr. K. Krishnamurthy Rao in the nascent Biotechnology Center. He then joined the Ph.D. program in Biology at the University of Rochester, under the mentorship of Tom Eickbush, studying the evolutionary origins of retrotransposable elements. He then arrived in Seattle to work on the evolution of centromeric histones and other assorted problems in Steve Henikoff's lab, funded by a postdoctoral fellowship from the Helen Hay Whitney Foundation. Tired of moving and because he is such a Mariners fan, he decided to stay at the Hutch after his postdoctoral term and started his lab in fall of 2003!

Harmit is interested in a variety of problems that could all be classified under the genetics of evolutionary conflict. He studies rapidly evolving proteins as a hallmark of this kind of conflict, hoping to better understand the molecular nature of the conflict, as well as uncover previously unrecognized sources of conflict. His lab is currently working on several rapidly evolving projects—including centromeres and heterochromatin, nuclear import and variant histones, and innate defense strategies against retroviruses. Harmit's role in the lab ranges from supervising the projects of other lab members to serving as their glorified technician.

Harmit is married to Chandni and has two young sons, Aman and Vivek. He used to be an avid reader of comic books and graphic novels. After Aman and Vivek, he is getting interested in linguistic studies of toddlers!



**Principal
Investigator**
**Fred Hutchinson
Cancer Research
Center**