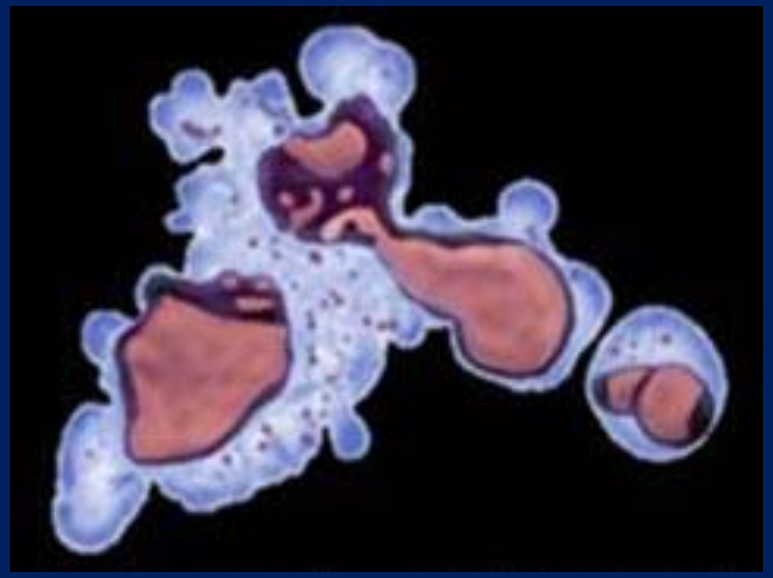
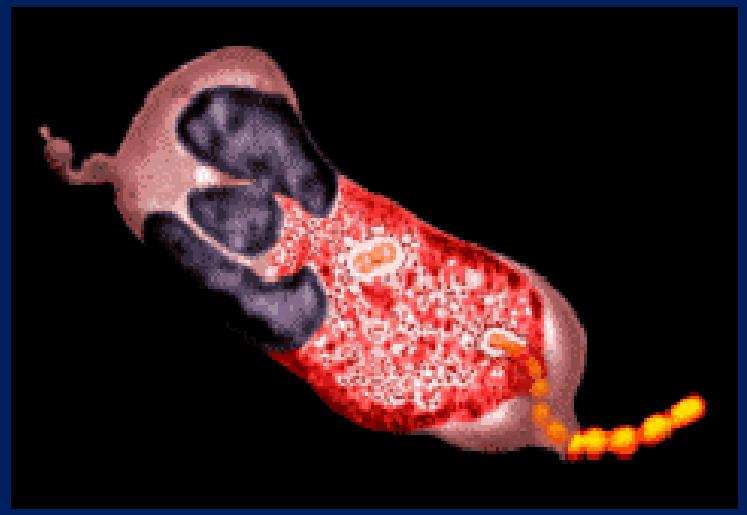
Welcome to BB101 Biology



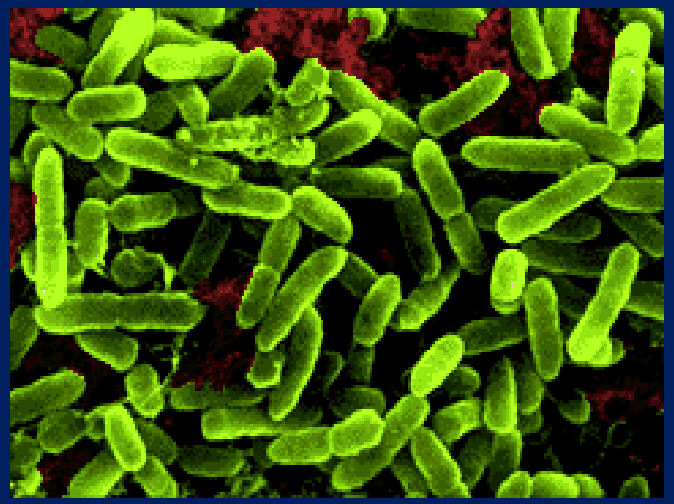
Leukemia cell committing suicide (apoptosis)

Can we make all cancer cells do this?



A human white blood cell is eating a bacteria to kill it

Can a cancer cell be killed this way?



Scanning electron micrograph of soil bacteria

What is the use of studying soil bacteria?

Images copied from www.cellsalive.com/gallery.htm

Molecular and Cellular Biology (MCB)
BB 101

Dr. Sandip Kaledhonkar
Department of Biosciences and Bioengineering
Email: sandipk@iitb.ac.in
Phone: 7706

Class 1

Part I. Structure of the course

Part II. Learning objectives for today

- Introduction to Biology
- How Engineering / Technology and Biology are interwoven with each other

Why this course?

- To provide good background of biological concepts & issues of societal impacts
- Biology is going to influence you in one or the other way so having good understanding of subject will prepare you
- Combination of Biology knowledge with core Engineering, Physics or Chemistry may contribute to biomedical research
- This course may help you understand and appreciate how Biology/ Engineering & Technology are interwoven with each other

Instructors

Module	Instructor	Quiz	Mid-sem	End-sem	Total
Molecular and Cell Biology (MCB)	Prof. Sandip Kaledhonkar sandipk@iitb.ac.in	5	20	0	25
Molecular and Cell Biology (MCB)	Prof. Sreelaja Nair		25	0	25
Physical Biology	Prof. Ambarish Kunwar	5	0	20	25
Biomedical Engineering	Prof. Hari Varma	5	0	20	25

Online Attendance: mandatory

Minimum 30%

Class timings

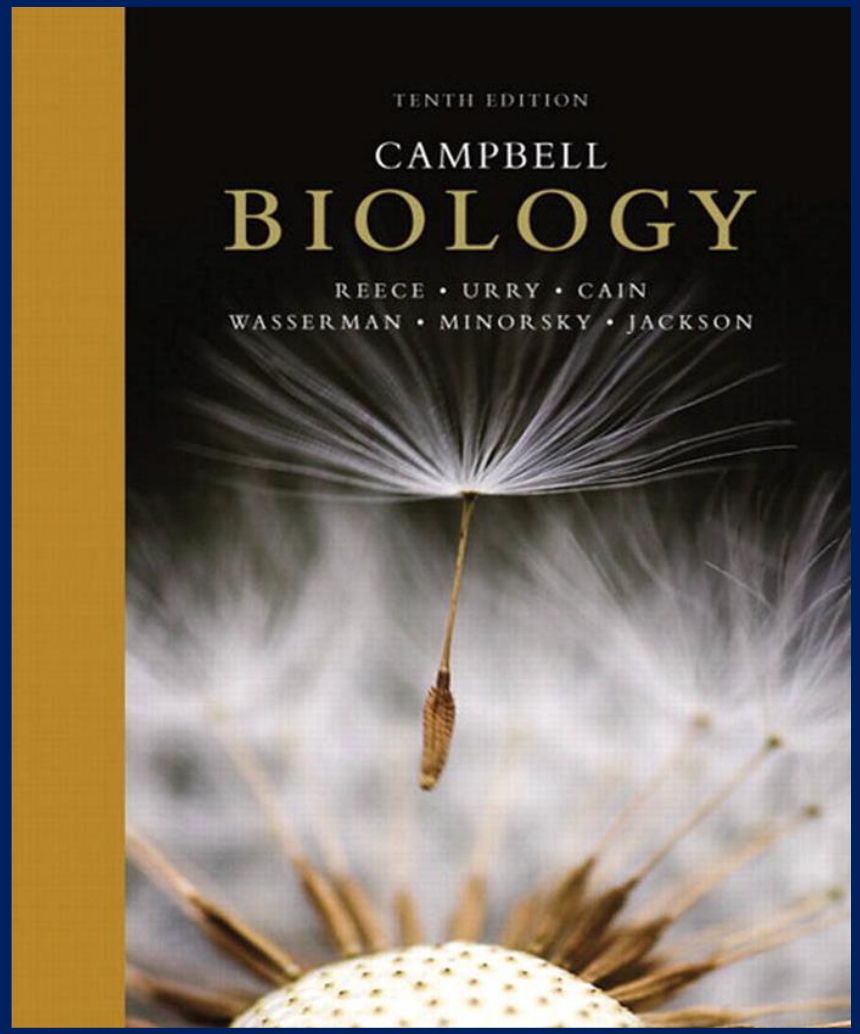
Division	Class	Slot	Tutorial Slot	Students from
D1	Tuesday 11:30AM to 1:00 PM	3B	X3 4:00-4:55 PM	CS, EE
	Thursday 8:00 to 9:30 AM	3C		
D3	Tuesday 3:30 to 5:00 PM	11A	X1 2.00-2.55 PM	ME, EP, CH, EO, MA
	Friday 3:30 to 5:00 PM	11B		

Online lectures: via Zoom

Tutorial: online mode via Microsoft Teams

Lecture handouts and video recording will be posted on Moodle

Reference book



Excerpts from selected chapters

Campbell Biology, 10th edition

by Reece, Urry, Cain,
Wasserman, Minorsky, Jackson

Pearson publishers

Topics to be discussed

Topic	Chapter(s)
UNIT 2: THE CELL	
Introduction	1
A tour of the cell	6
Metabolism and respiration	8, 9
Respiration and photosynthesis	9, 10
Cell communication	11
Cell cycle	12
UNIT 3: GENETICS	
Mendel and Gene Idea	14
Molecular basis of inheritance	16
Flow of information	17
Regulation of gene expression	18

Total 6 Lectures

Each Unit: 3 Lectures

Part II. Learning objectives for today

Molecular and Cell Biology

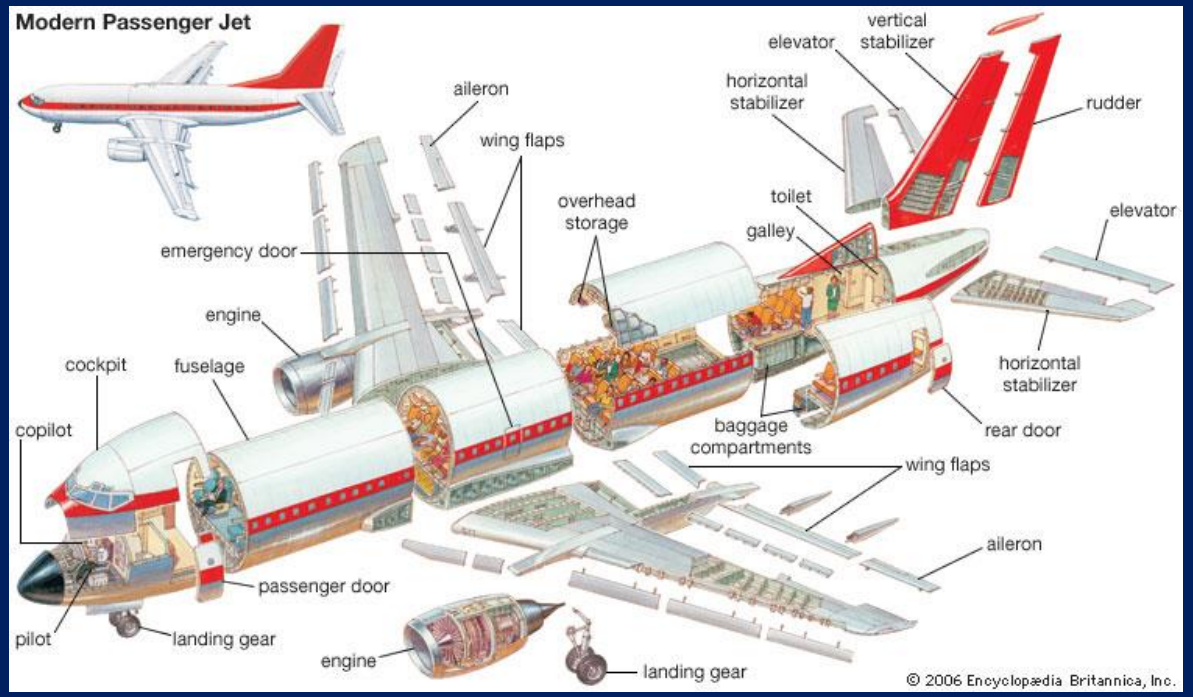
Part I. Structure of the course

Part II. Learning objectives for today

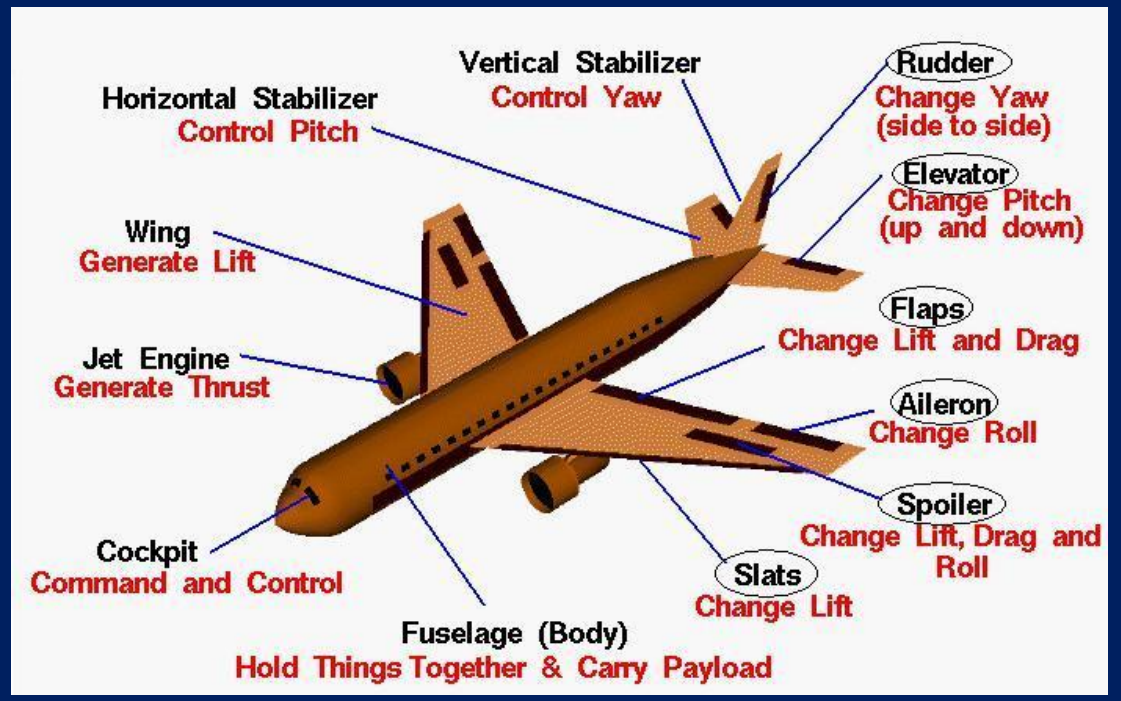
- Introduction to Biology
- How Engineering / Technology are interwoven with each other

Aeroplane: parts and function

It is essential know what various parts of an aeroplane are called and what they are meant for

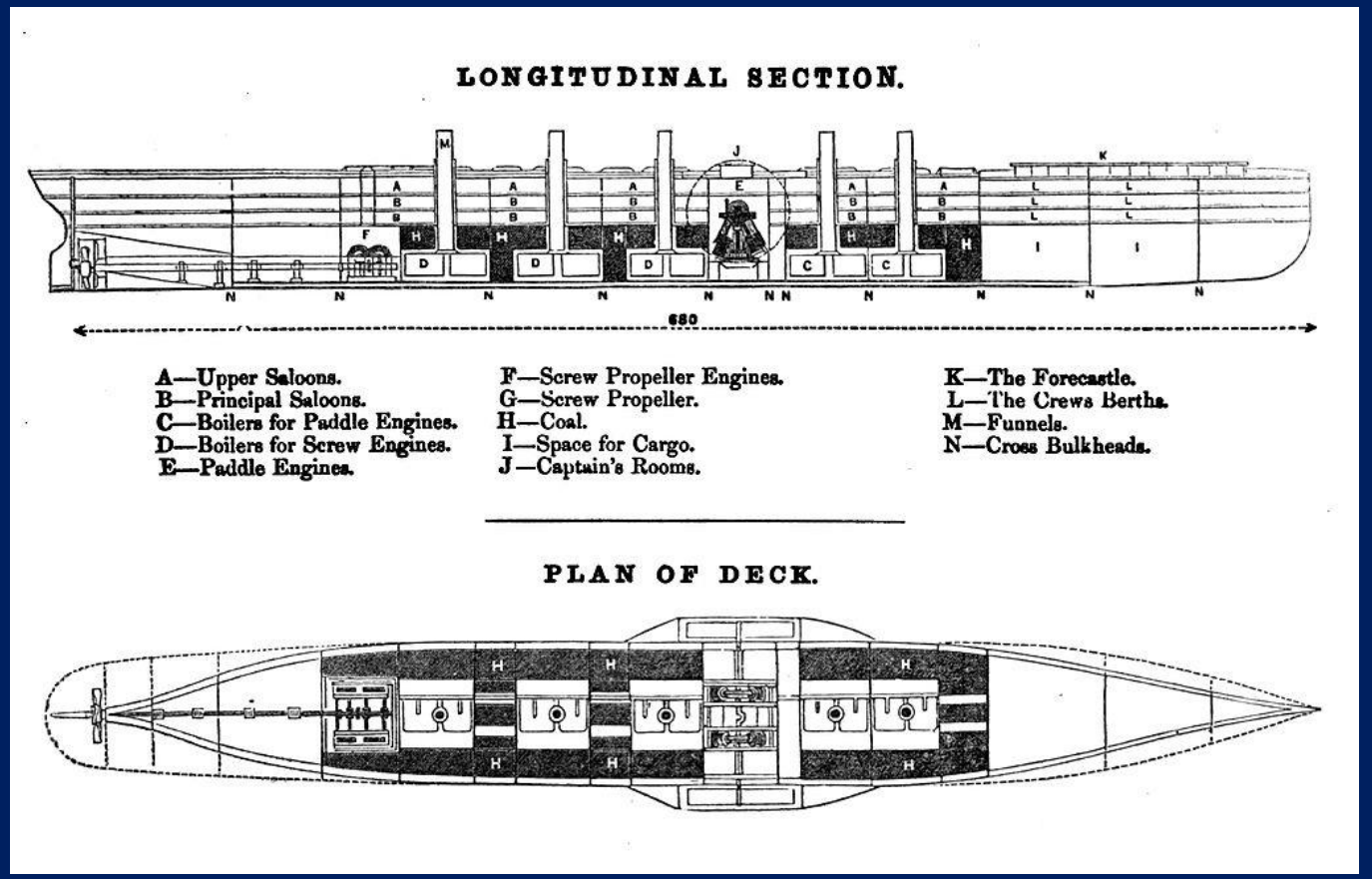


kids.britannica.com/elementary/art-88070/An-illustration-shows-cross-sections-of-a-Boeing-737-passenger



www.wikiwand.com/en/Harry_Aubrey_Toulmin,_Sr.

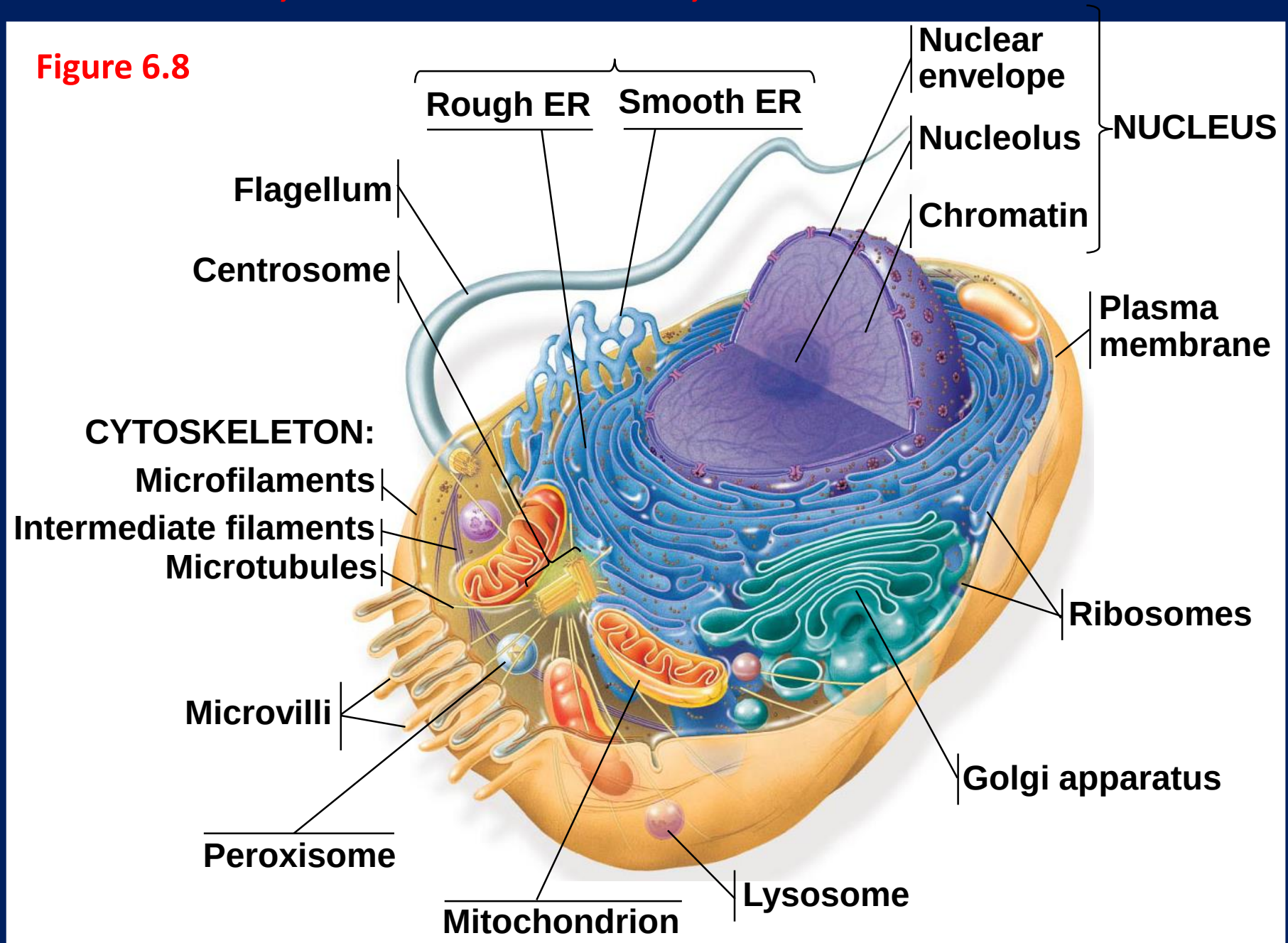
Parts list, their function, mutual coordination…



upload.wikimedia.org/wikipedia/commons/thumb/d/d8/SS_Great_Eastern_diagram.jpg/1024px-SS_Great_Eastern_diagram.jpg

Parts list, their function, mutual coordination…

Figure 6.8



Nature has its own rules, principles, laws, …

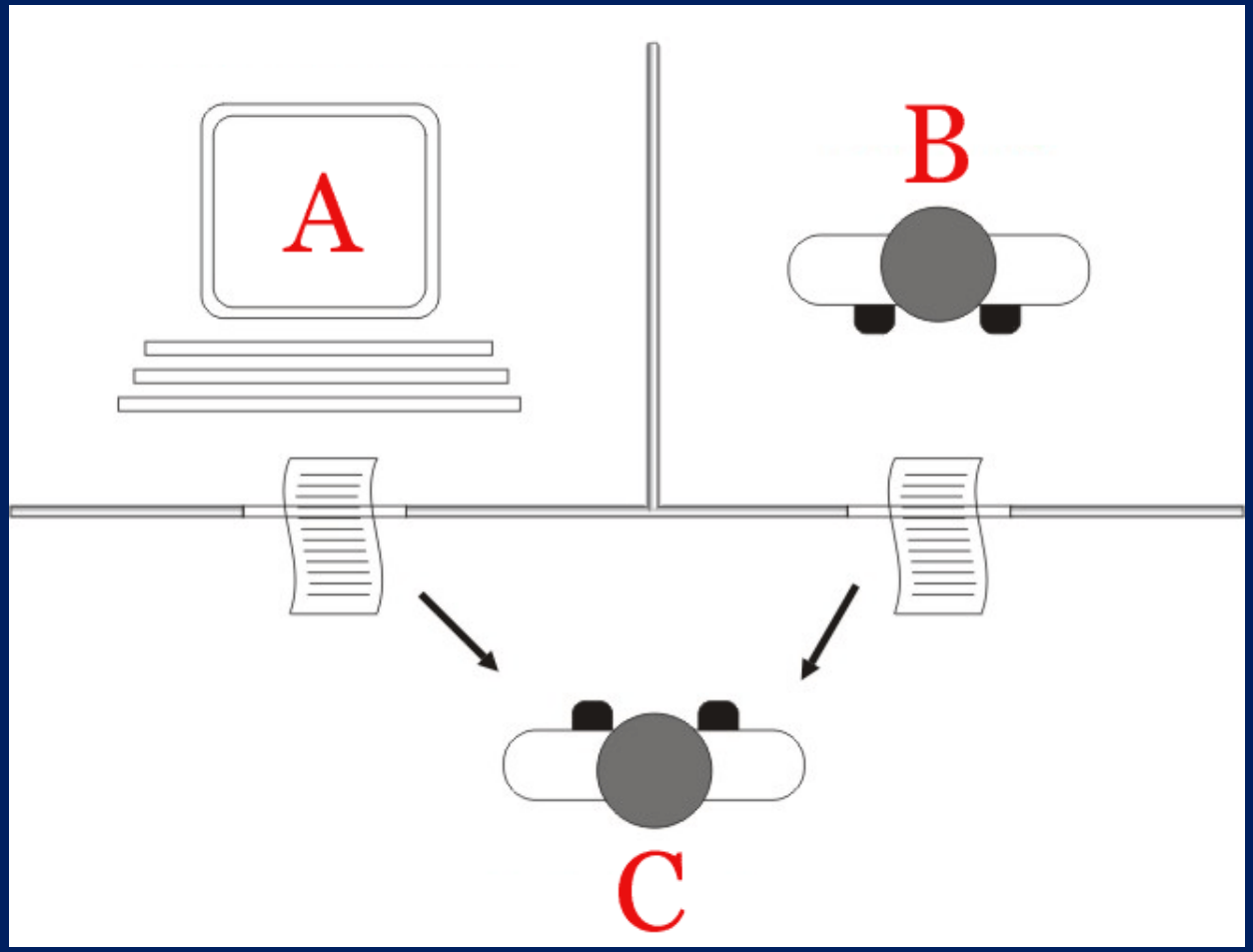
Biology is a vocabulary-rich science (it has to be, like that of any other complex and self-regulated system)

Living systems work within the framework of the laws of Physics and Chemistry

Across the globe, efforts are on to teach Biology so as to bring out the (i) beauty of life, (ii) benefits of understanding how they work and (iii) challenges associated with study

What is life?

Can machines think?



A: Computer
B: Human
C: Human

A, B: hidden behind a screen

C types a question and gets a response from A or B

Can C guess correctly who responded: A or B?

Does life mean “intelligence”?

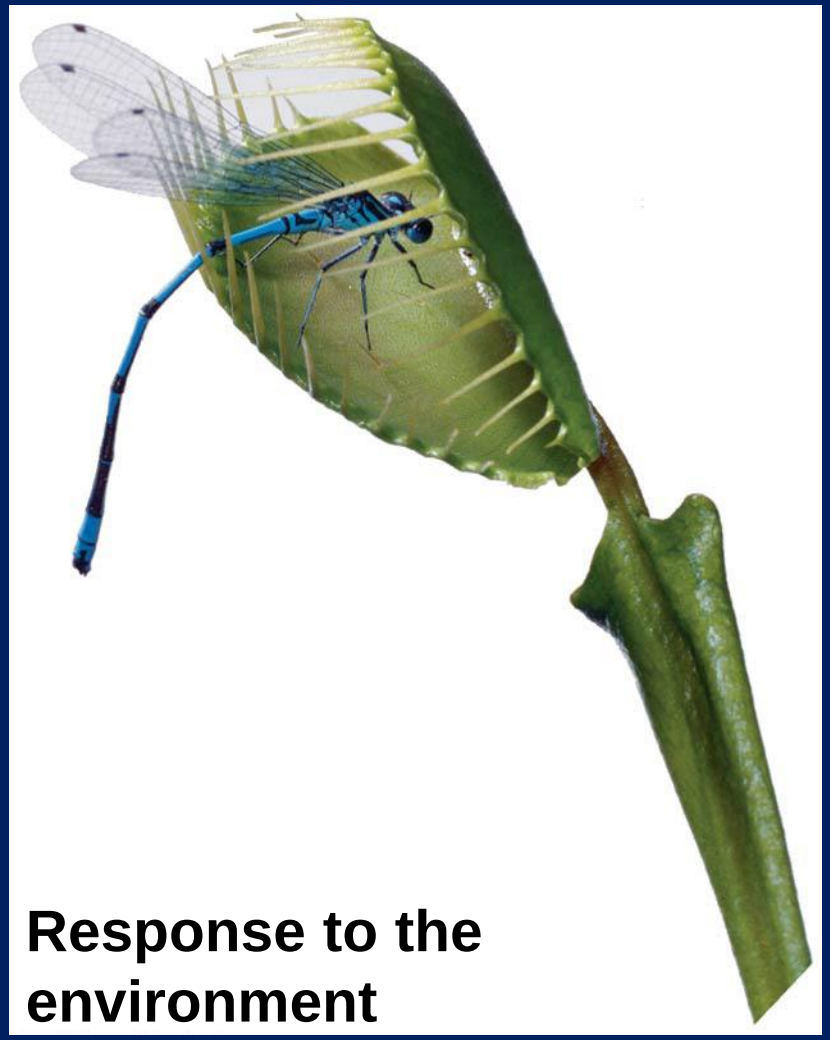
Evolution of robots and artificial intelligence

Stockfish chess engine

Xenobots: AI-designed (C-shaped) organisms push loose stem cells (white) into piles as they move through their environment

Team builds first living robots—that can reproduce (harvard.edu)

Does life mean “ability to respond to environment”?



A damsel fly lands on this venus flytrap

The fly immediately closes its trap so that the fly cannot escape

This is a form of responding to the environmental stimulus

Does life mean “ability to respond to environment”?

Energy processing

This moth is getting fuel in the form of nectar of the flowers

Chemical energy stored in the nectar is used to power flight and perform other work, including growth and development

Does life mean “growth and development”?

Growth and development

Inherited information carried by genes controls the pattern of growth and development

Does life mean ability to “reproduce”?

Reproduction

Organisms (or living creatures) reproduce their own kind

Does life mean “regulation”?

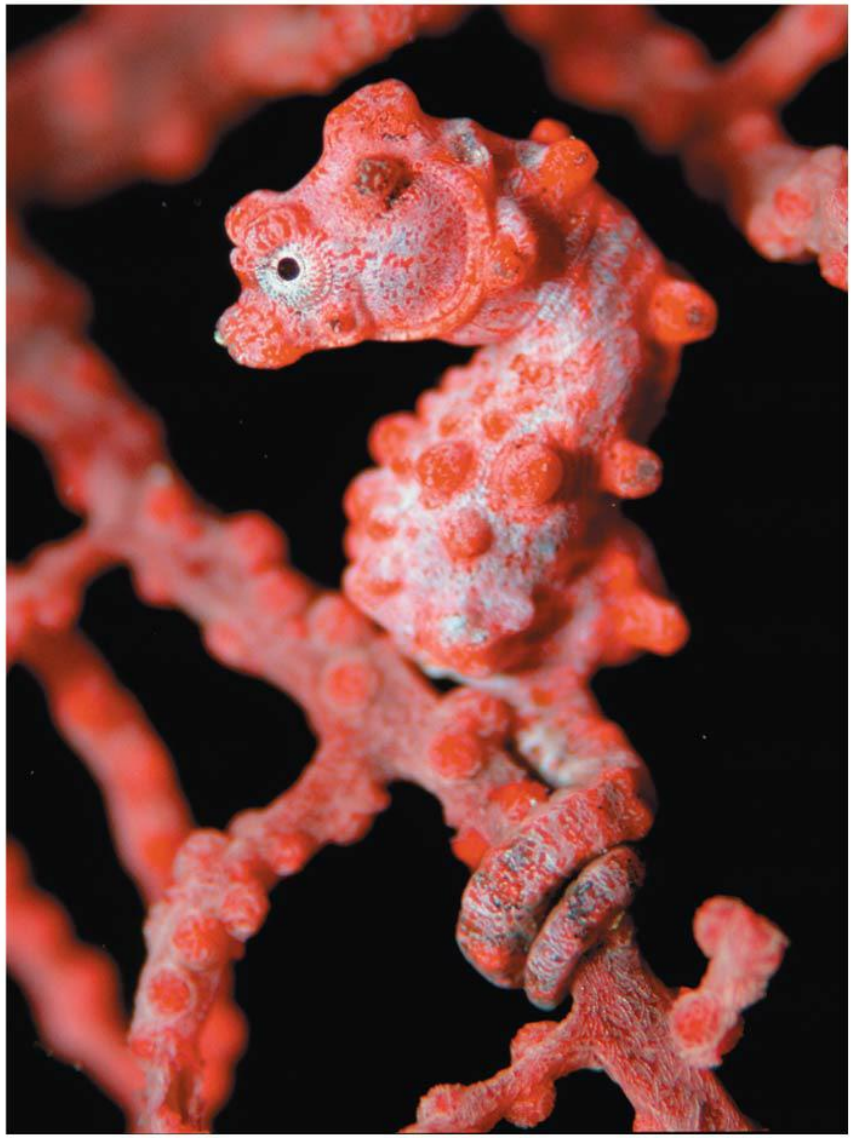
Regulation

This jackrabbit maintains a constant body temperature

Blood flow through the blood vessels in its ears is regulated to adjust heat exchange with the surrounding air

Is this the reason why it has such large and thin ear lobes?

Does life mean “ability to adapt”?



Evolutionary adaptation

Its appearance camouflages it in its surroundings

This is an adaptation that has evolved over many generations

Individuals which inherit traits that best suit the environment survive; others perish

Does life mean “order”?

Order

This close-up of a sunflower illustrates the highly ordered structure that characterizes life

How to pack seeds with optimal utilization of space?

Same pattern can be found on a daisy, pineapple, pinecone, broccoli, cauliflowers, …

Recognizing life…

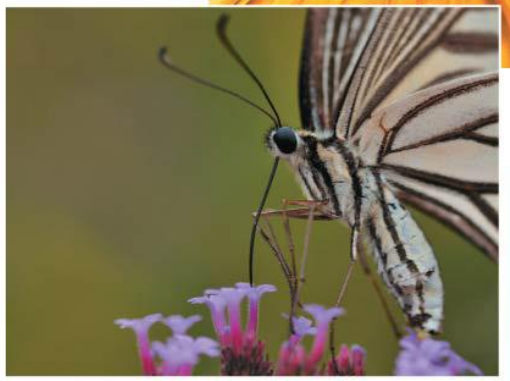
Figure 1.2

Order

Evolutionary adaptation

Regulation

Reproduction



Energy processing

Growth and development

Response to the environment

Unifying themes of life

- Organization
- Information
- Energy and matter
- Interactions
- Evolution

Concept 1.1, p48

Theme #1: Organization

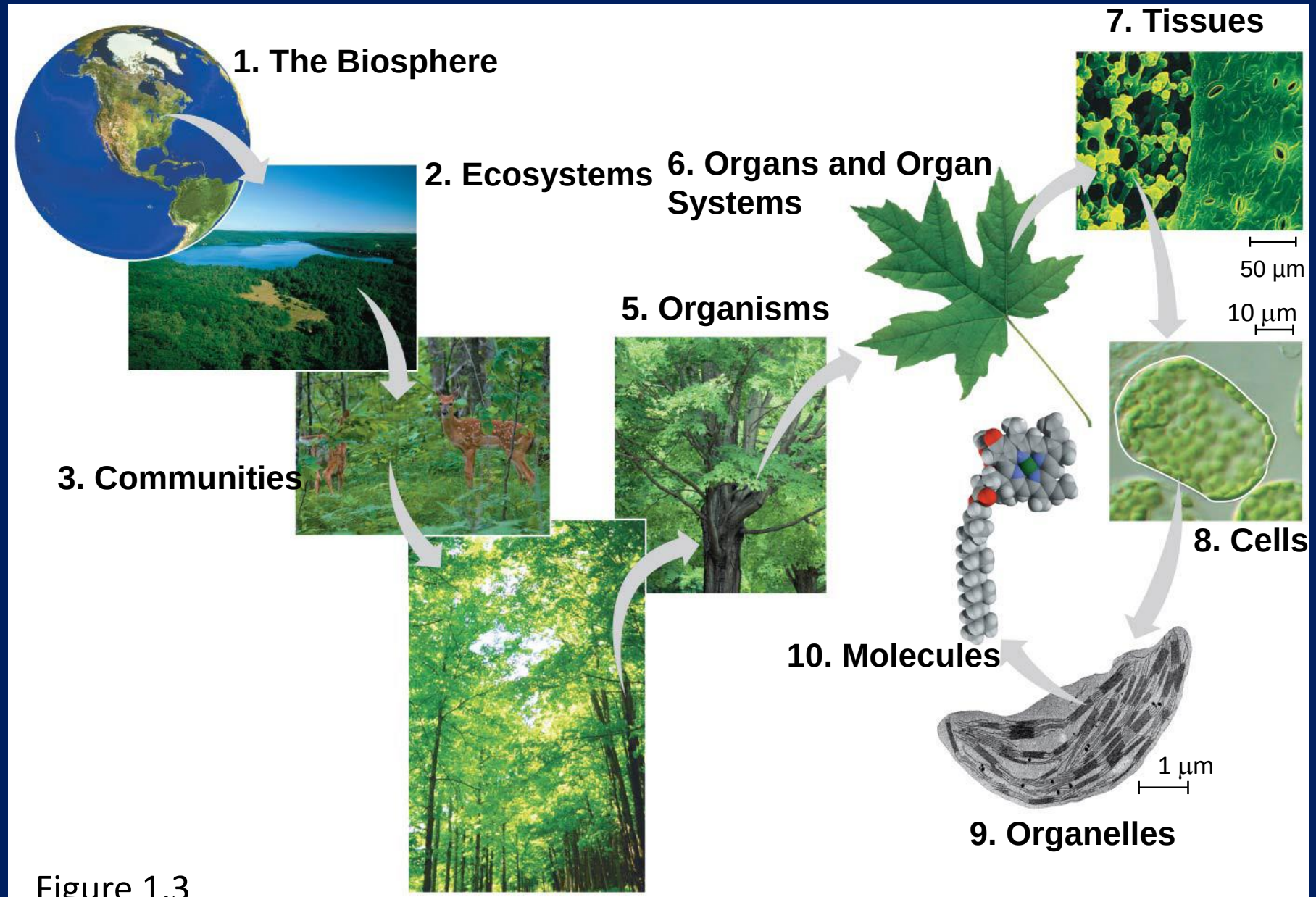


Figure 1.3

Theme #2: Information

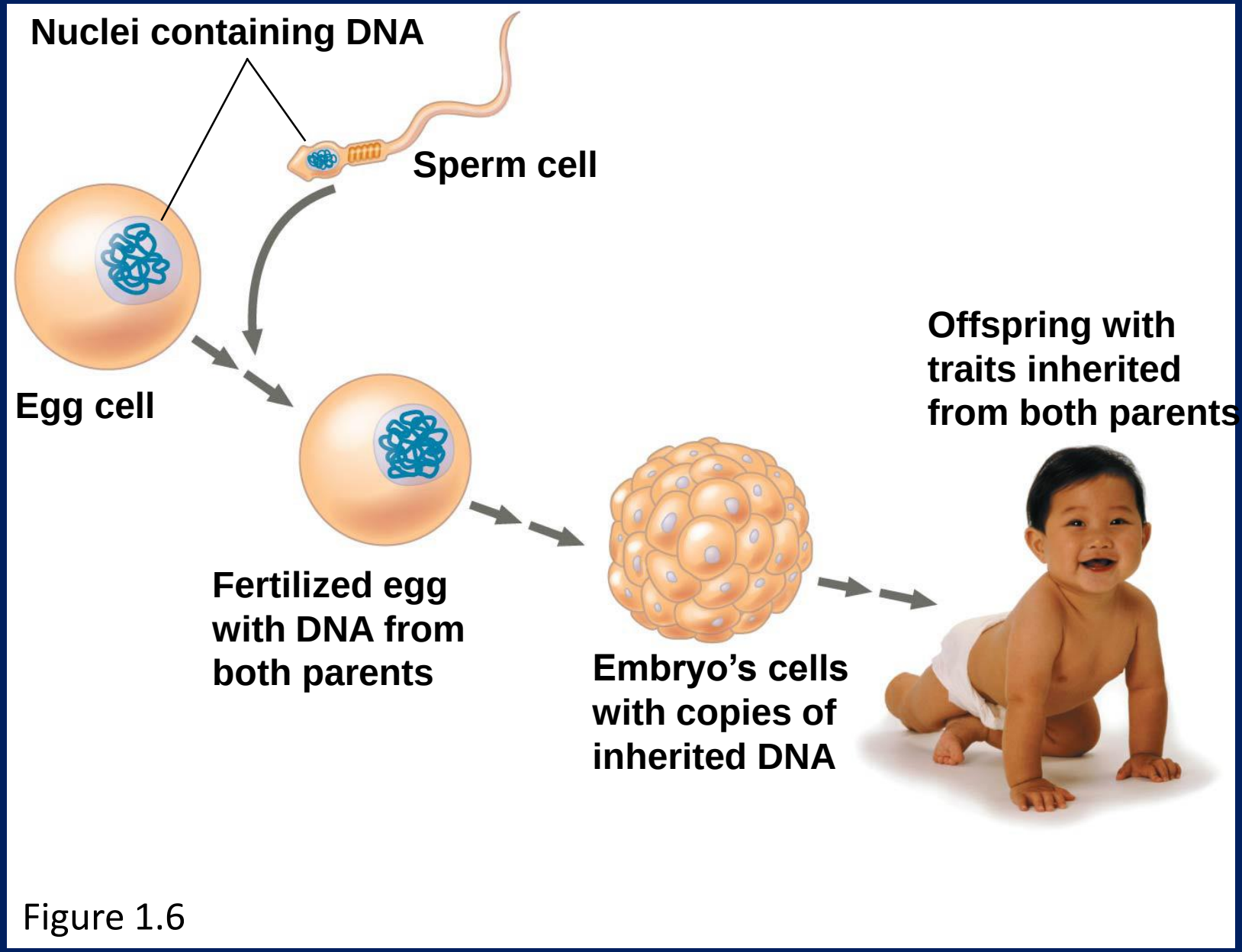


Figure 1.6

Theme #2: Information

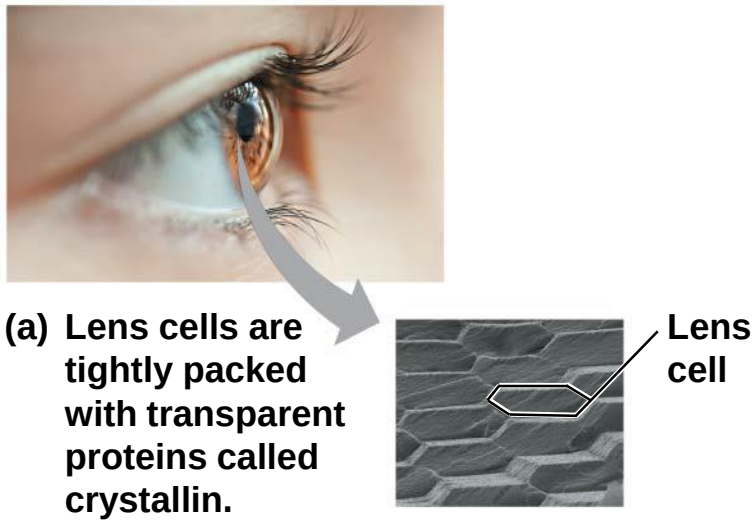


Figure 1.8

Theme #3: Energy and matter

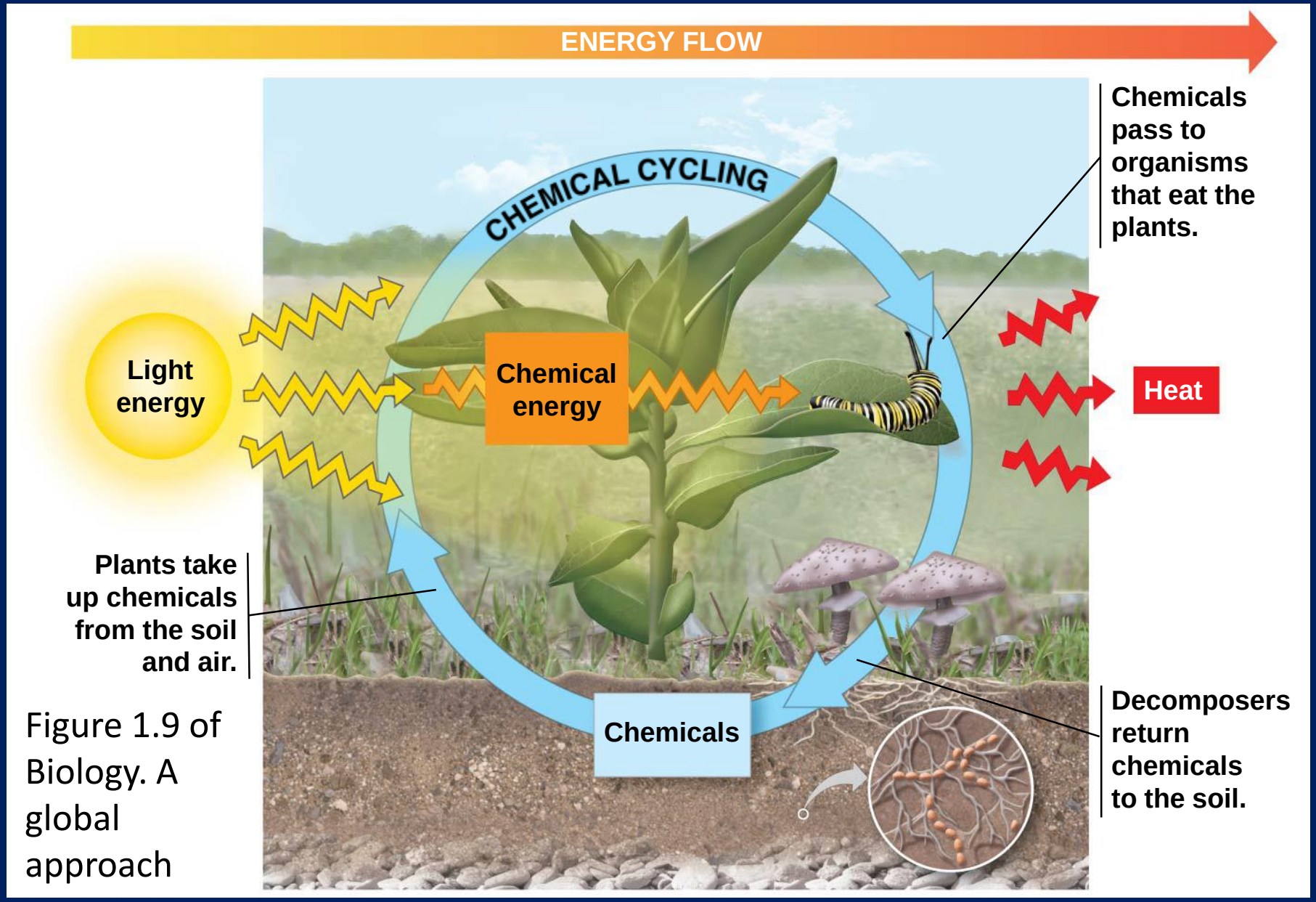
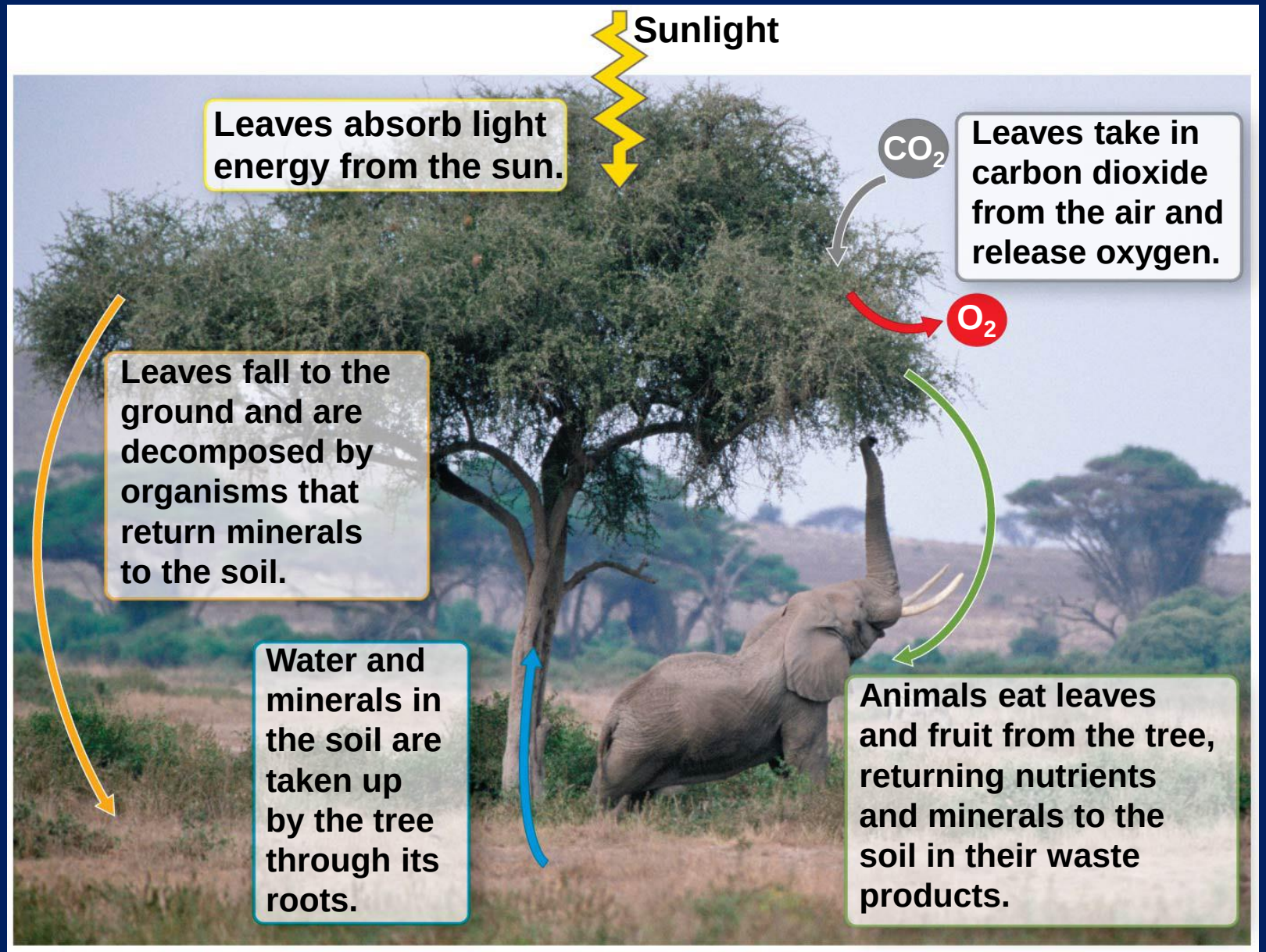


Figure 1.9 of Biology. A global approach

Theme #4: Interactions

Figure 1.10



Theme #5: Evolution

Figure 1.19
Evolutionary adaptation

Figure 1.18
Natural selection

1 Population with varied inherited traits

2 Elimination of individuals with certain traits

3 Reproduction of survivors

4 Increasing frequency of traits that enhance survival

Diversity is a hallmark of life

- Biologists have so far identified 1.8 million species
- 100,000 species of fungi
- 290,000 species of plants
- 52,000 vertebrates
- 1,000,000 insect species
- Myriad number of single-celled organisms

Concept 1.2, p58

Taxonomy (why many hate Biology!)

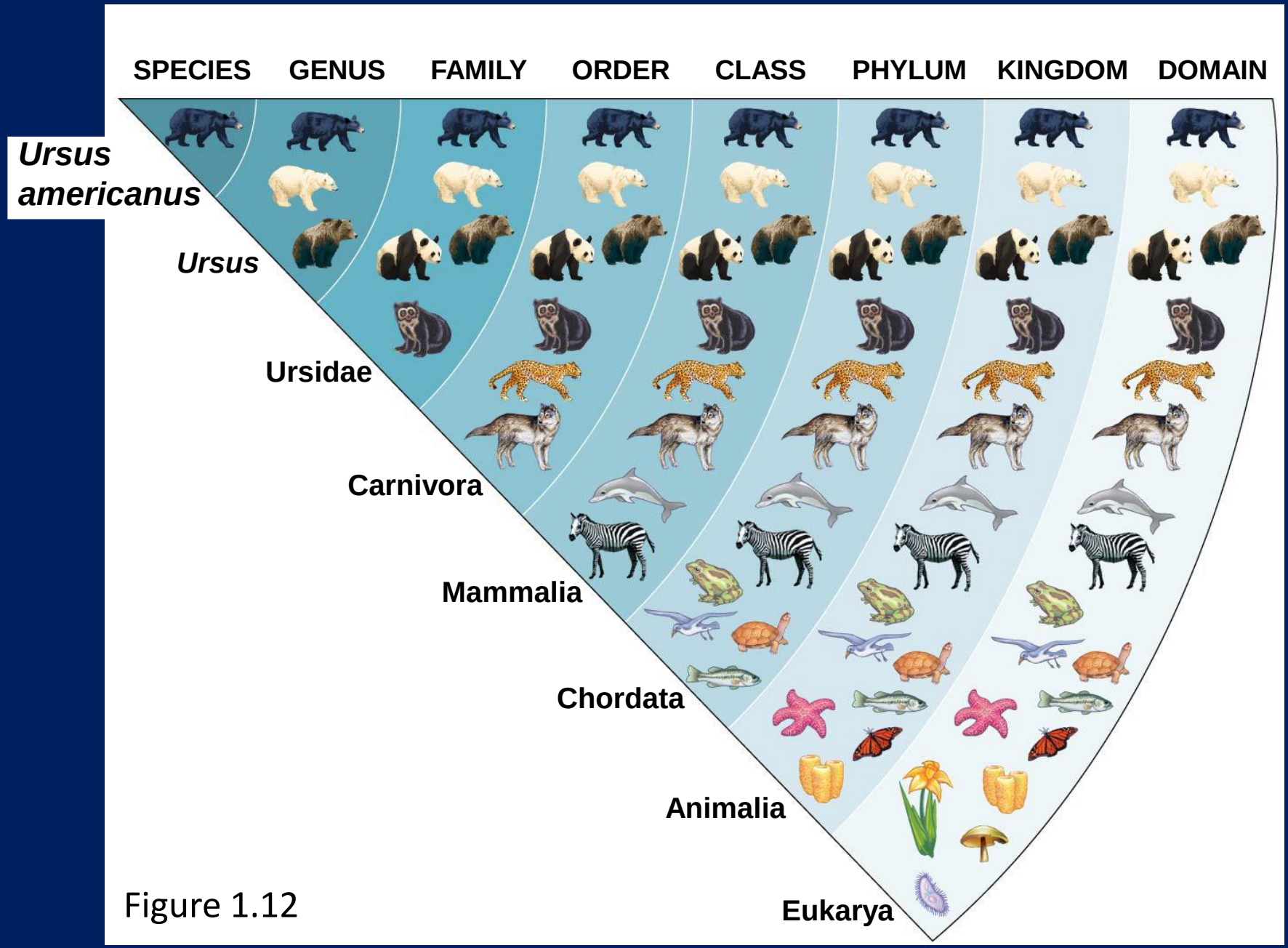


Figure 1.12

The three domains of life

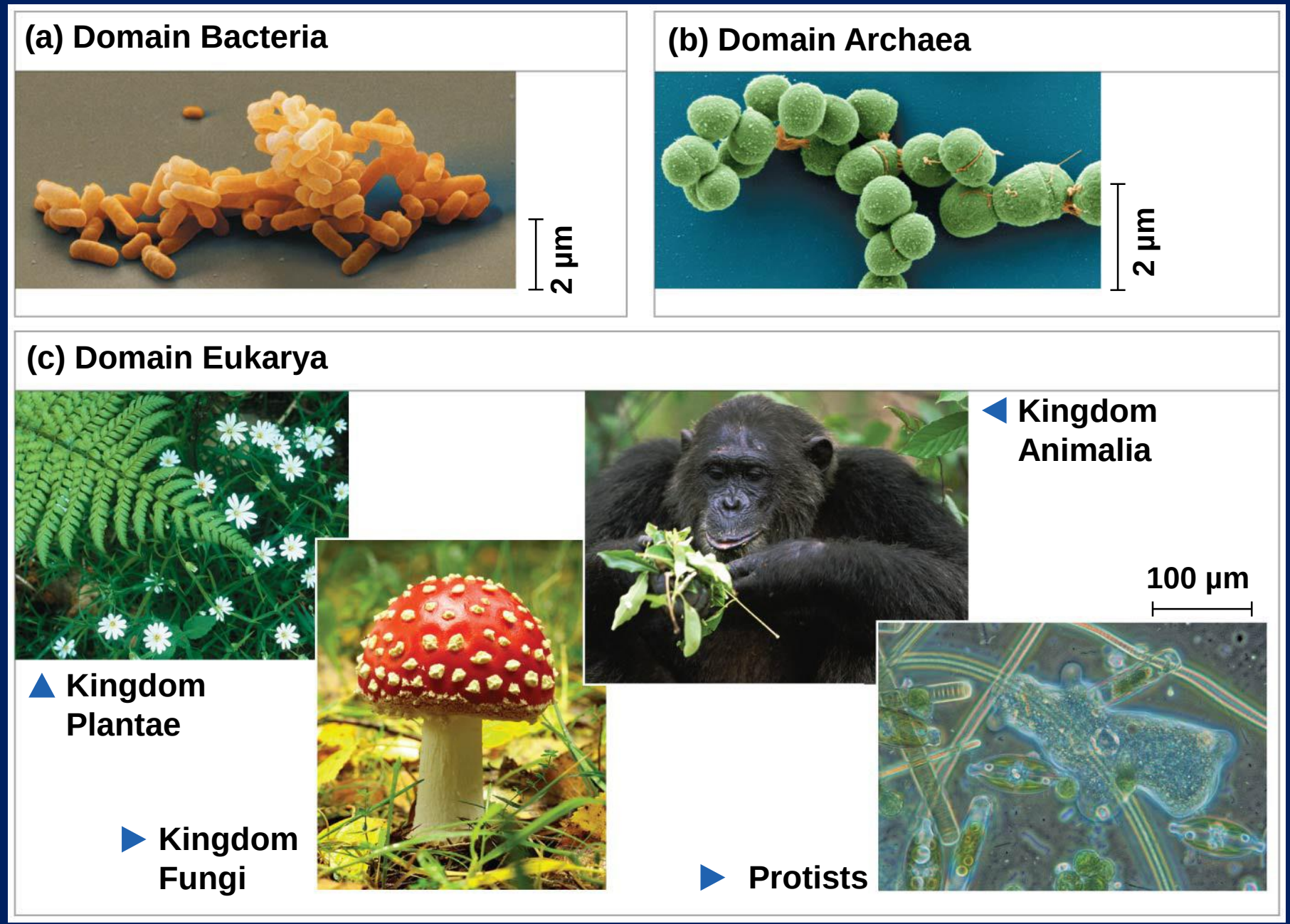


Figure 1.13

Unity in diversity

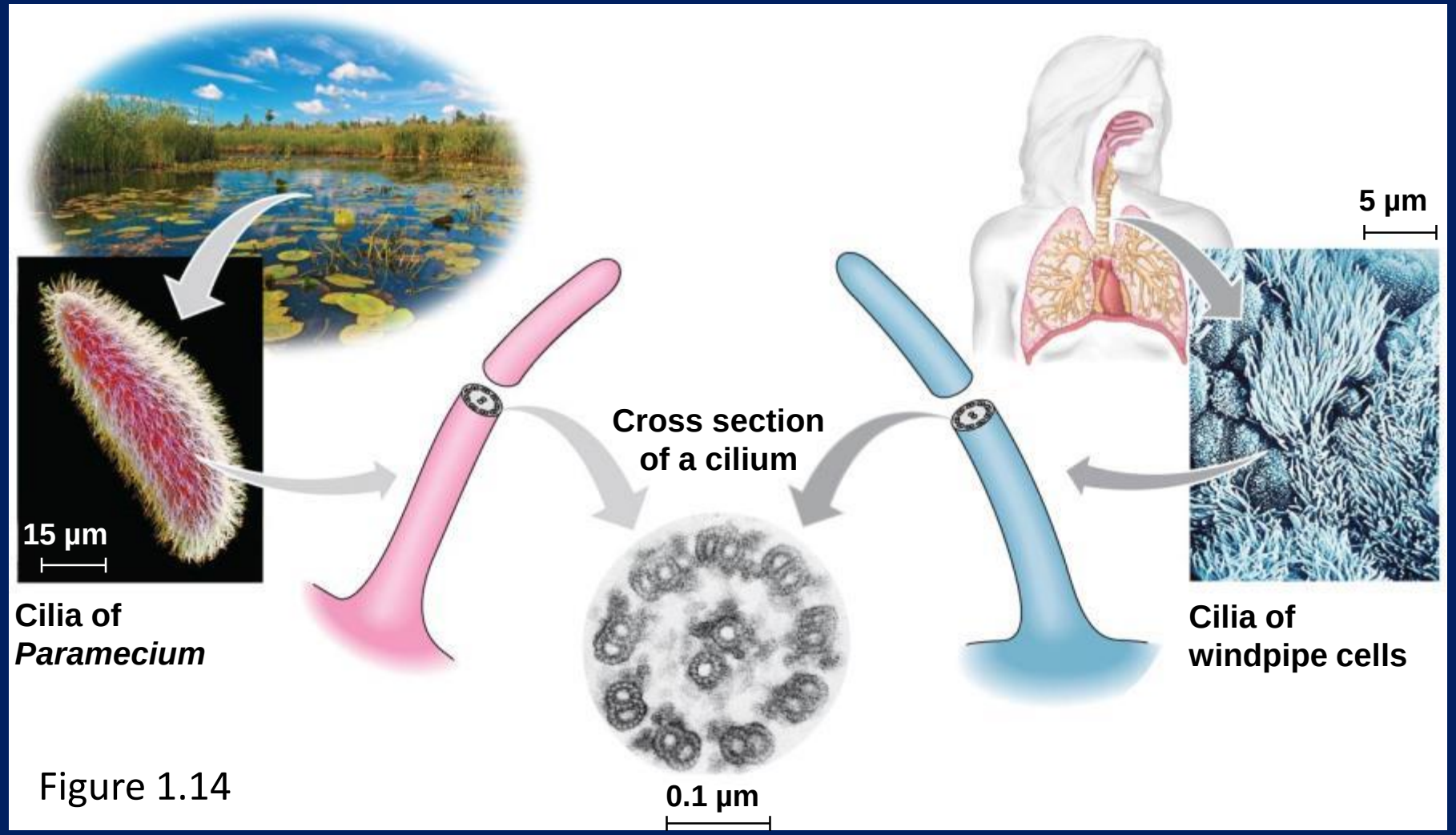
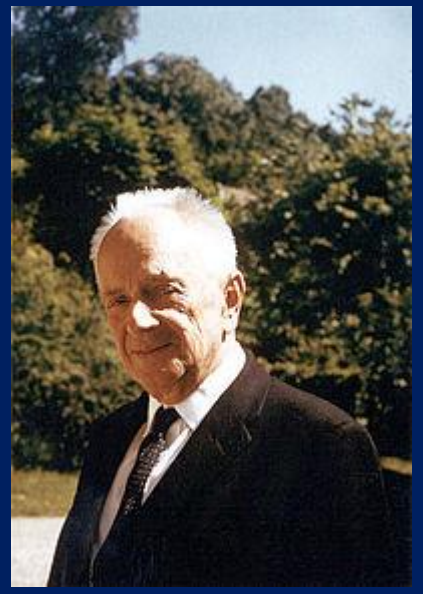


Figure 1.14

Evolution, unity and diversity

Nothing in biology makes sense except in the light of evolution



Theodosius Dobzhansky
Ukranian / Russian
1900-1975
Image: Wikipedia

- We see a lot of diverse life forms around us
- Biologists have found remarkable similarities in components, reaction pathways, etc. across life forms
- AN UNDERLYING UNITY DESPITE DIVERSITY
- All life forms have evolved from a set of common ancestors
- Adapt to (changing) external environment

Inquiring about life

www.theviralfeed.in/drought-worsens-in-maharashtra

Mother-of-pearl or ghost plant

www.warrenphotographic.co.uk/01678-mother-of-pearl-plant-with-captured-drop-of-water

Adaptation to environment
Time scale for adaptation

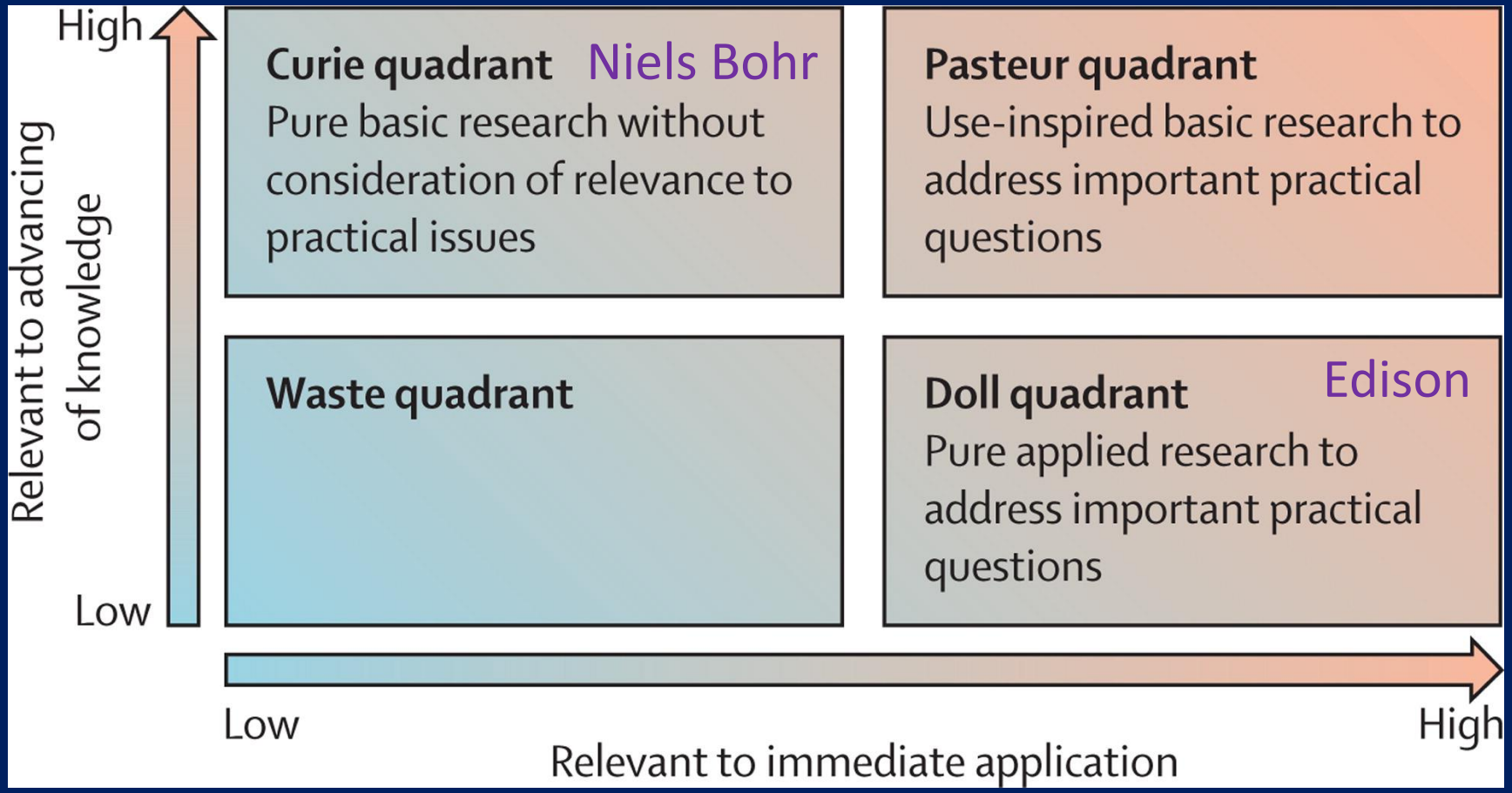
Invention versus discovery

Representative discoveries
Newton’s laws of motion
Inverse square law of gravity
Continental drift
Periodicity of elements
Circulatory system
Nervous system – electrical impulses
Moons of Jupiter
Radioactivity

Representative inventions
Wheel
Electric bulb
Automobile
Aeroplane
Radio and television
Printing press
Internet
Telephone

From the internet

Biology research: invention or discovery?

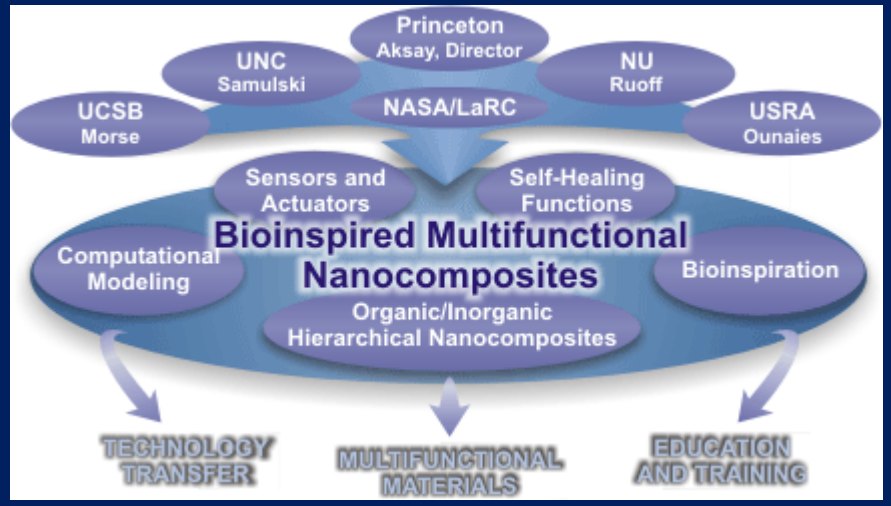


Which quadrant does Biology research belong to?
Waste quadrant?!

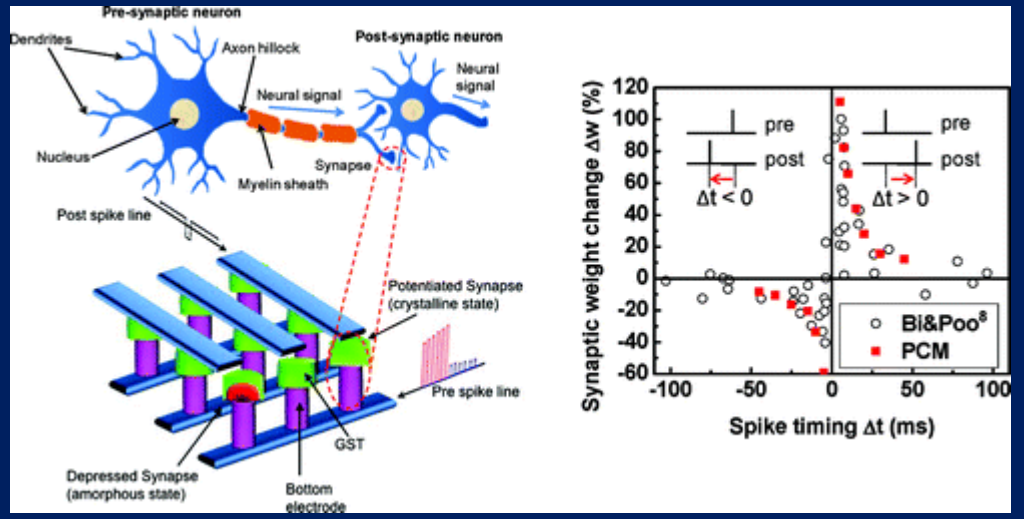
Lancet (2014) 383:156-165
Original: book entitled Pasteur's quadrant by Donald Stokes

Richard Doll – showed that smoking causes lung cancer

Bio-inspired…



www.bimat.org/overview.cfm



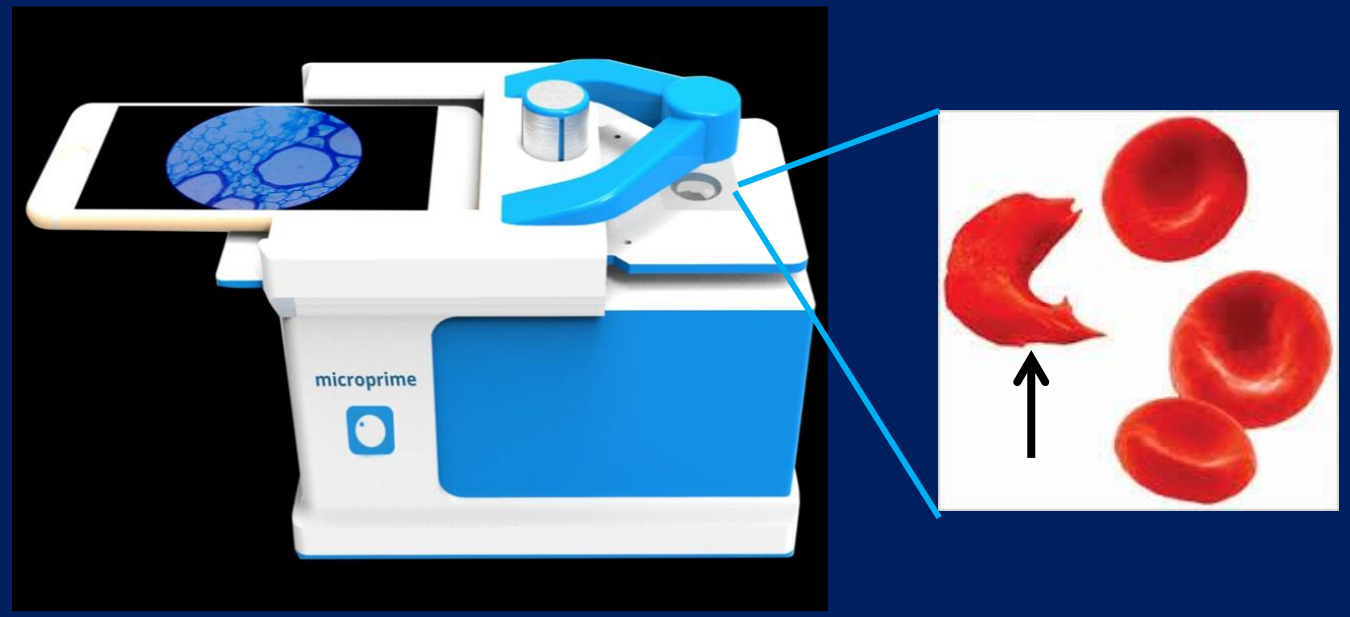
nextbigfuture.com/2011/06/nanoelectronic-programmable-synapses.html

Bio-inspired materials,
Bio-inspired computing,
Bio-inspired robotics,
Bio-inspired plastic,
Bio-inspired technology,
…

robotsinsider.com/t8-a-bio-inspired-robot-is-so-accurate/

Biology, Engineering & Technology @ IIT Bombay

Mobile-phone based diagnostic platform to detect sickle cells in blood at point-of-care



www.bio.iitb.ac.in/~dpaul/research.html

Biology, Engineering & Technology @ IIT Bombay

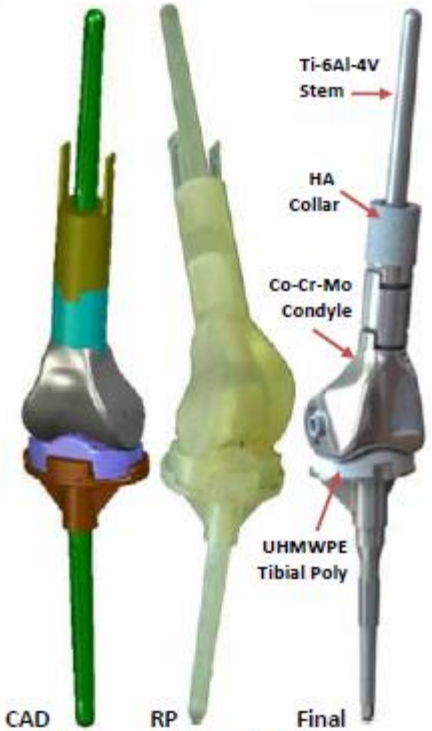
Product Overview

uChek: Lab Made Mobile is a smartphone based portable diagnostic system. uChek can perform a wide variety of tests ranging from routine urine analysis to specialised tests such as determining the albumin to creatinine ratio in urine as well as blood sugar test. uChek is a platform technology to which we will continue to add tests as we develop further. It has a Laboratory equipment equivalent accuracy and an intuitive interface at the same time. It can work for a limited period even without a power supply and has the ability to display geographical data for community level surveillance.

http://www.bio.iitb.ac.in/people/faculty/srivastava-r

Biology, Engineering & Technology @ IIT Bombay

Knee mega endo-prosthesis
(Modular rotating-hinge design suitable for Indian patients)



Bhansali, Ghyar and Ravi
"Auto-suturing device for laparoscopic surgery"
Indian Patent 1880/MUM/2013

Shah, Ghyar, Ravi and Shetty,
"Modular knee joint implant for anatomical variation"
Indian Patent 2575/MUM/2012