BIO 111 - Principles of Life I: Biomolecules, Genetics and Evolution

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Ravi Maruthachalam,
Nisha N Kannan
&
Ullasa Kodandaramaiah

School of Biology

IISER
THIRUVANANTHAPURAM

MODULE: OVERVIEW OF BIOLOGY

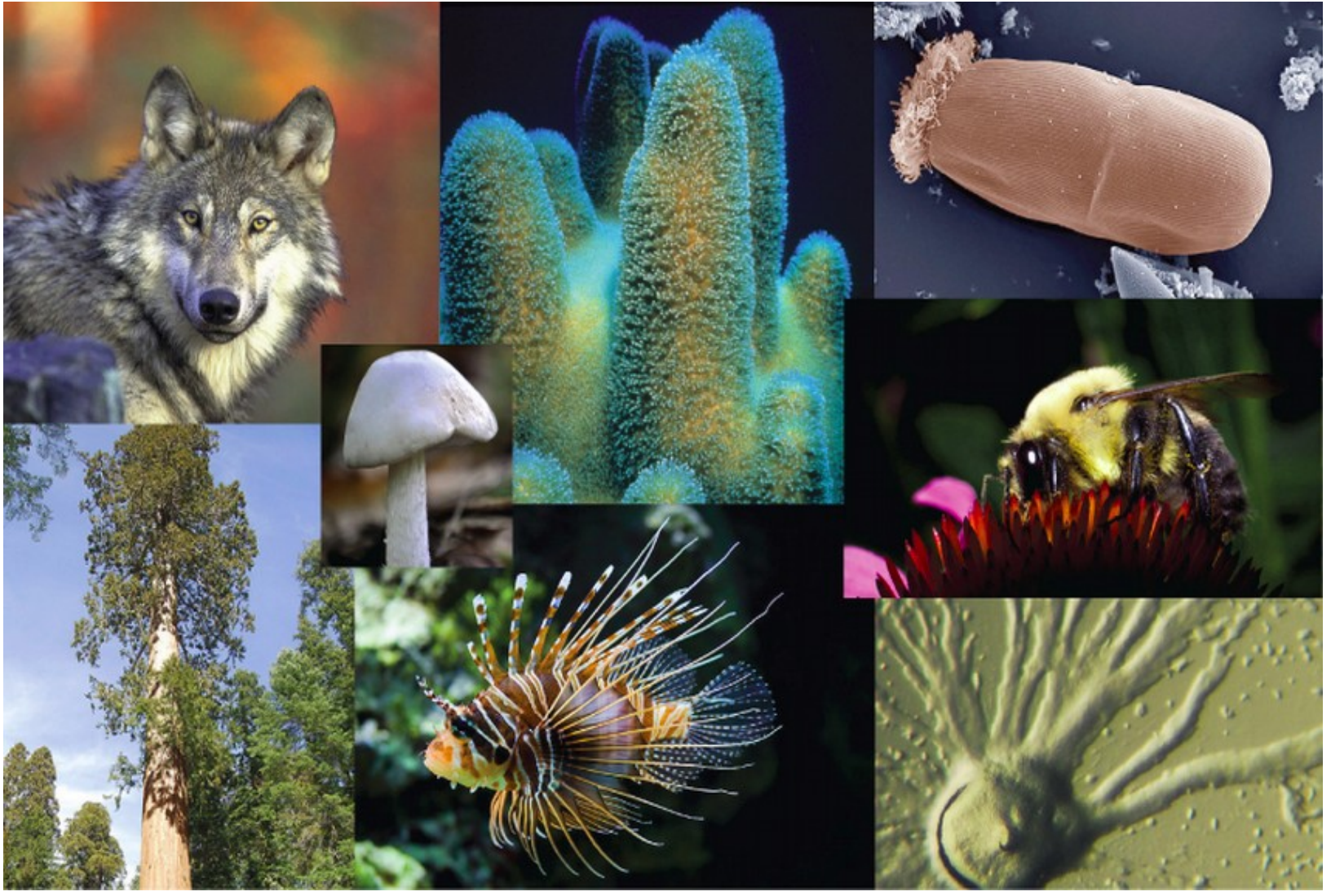
Part I – Introduction to Biology

What is Biology?

Study of life, living things

What is life?

www.felis.in



www.cnx.org

Life

- Difficult to define life
- *Assemblage* of molecules
- Life is a set of *processes*, not a thing or an event
- Can be described in terms of characteristics or features

‘*Emergent*’ properties: Whole is more than the sum of parts

e.g. A car is made of parts. The way the parts are assembled is what makes a car function

Letters by themselves mean nothing, but can come together to start a revolution!

- Similarly molecules get assembled in various ways to give rise to living things

- Hierarchical

  e.g. Molecules assemble to make up parts of a cell, cells assemble into organs, organs assemble into an individual

Characteristics of life

Features or *properties*

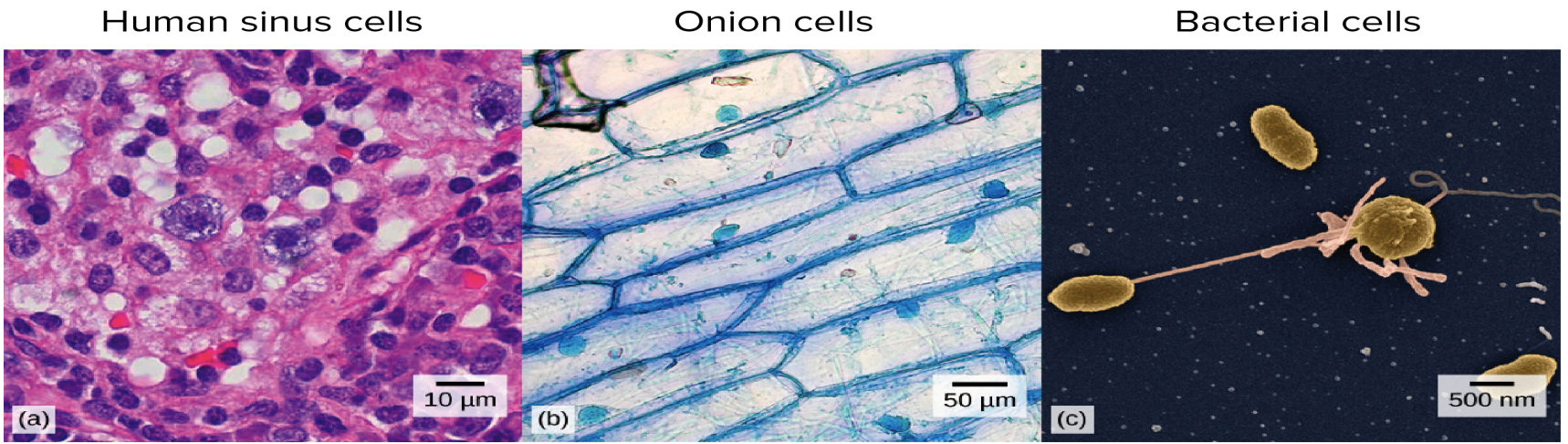
I. Cellular organization
II. Metabolism
III. Homeostasis
IV. Response to stimuli
V. Growth and development
VI. Reproduction & Heredity
VII. Evolution

(Note: Not all biologists describe life using the above processes, some do it in slightly different ways)

I. Cellular organization

Cells – basic building blocks of all living organisms

- Contained space that isolates reactions from the surrounding environment
- Smallest unit that can perform all the processes of life



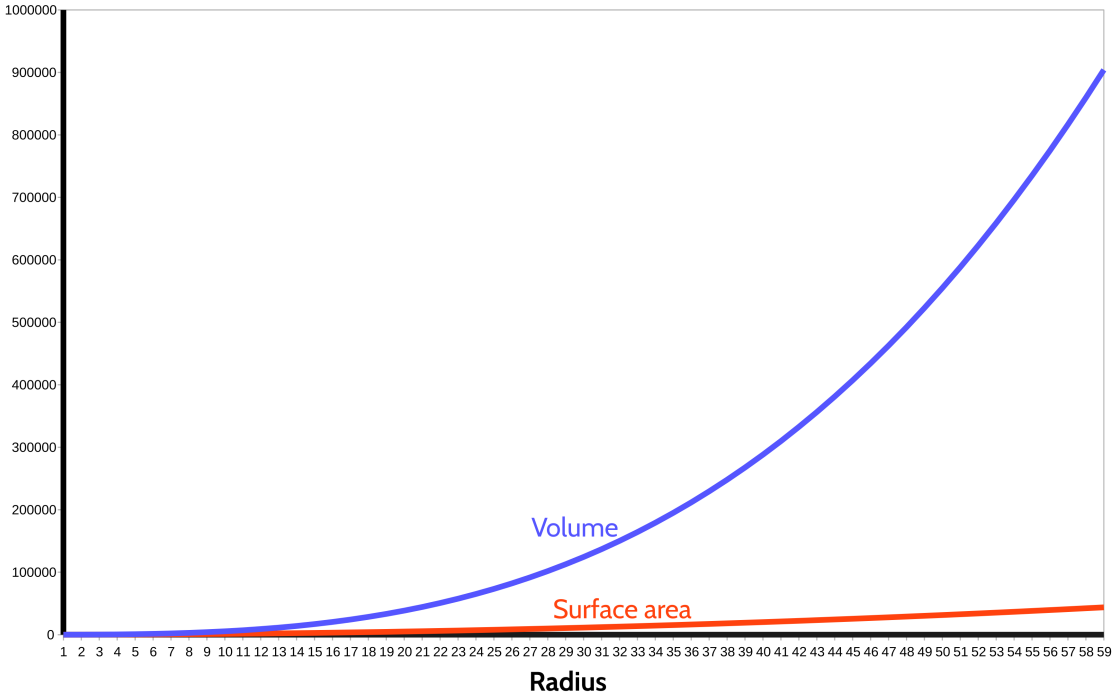
Source: https://www.khanacademy.org/science/biology/structure-of-a-cell/introduction-to-cells/a/intro-to-cells

- **Unicellular (e.g. bacteria)** versus **Multicellular** (cell specialization)
  e.g. Skin cells, Muscle cells

- Cells always small* (size of organism related to cell number)
  As size increases, volume increases much more rapidly than surface area, hence diffusion time increases

  **rare exceptions*

Volume and surface area for a sphere



(Reading) Exercise

- Rarely, cells are so large that they can even be seen with the naked eye. *Which are the largest cells found in nature?*

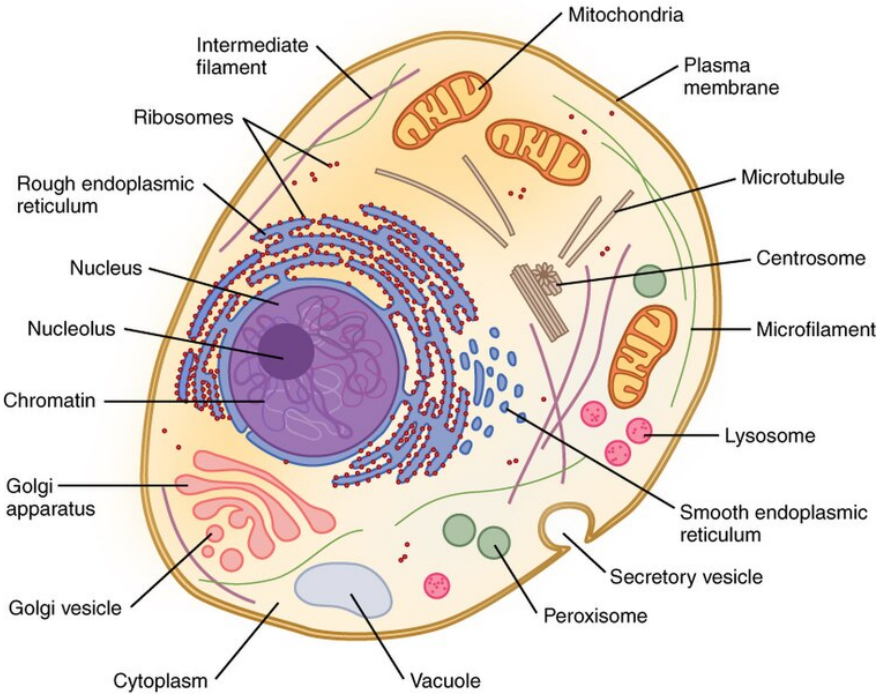
Cell

All cells have a **cell membrane** (also called **plasma membrane**), which is the border between the inside of the cell and the external environment

- Extremely important feature. *Why*?

- Cells contain molecules (proteins, carbohydrates, lipids, nucleic acids, water)

- Within the cell membrane, cells have various **organelles** and the **cytoplasm**
- Each organelle has a different function.
- For e.g *mitochondria* are the 'power houses' of cells where energy is produced from food



Source:
penstax.org/books/anatomy-and-physiology/pages/preface

DNA and Genes

- Organisms have chromosomes, which contain the genetic material, usually DNA.

- Genes are regions of the chromosome, and contain information for all of the processes of life

- The diversity of life is due to variation in genes among organisms

II. Metabolism

Sum of all chemical processes in an organism

- Obtain and use energy
  - for cellular processes
  - for making the building blocks of the cell
- Eliminate waste

“Life is an organized state of chemical reactions”

III. Homeostasis

Regulation - Keep internal conditions relatively constant under changing environmental conditions

In other words, maintenance of a stable body condition

Ex. body temperature, salt concentration

Metabolic processes are involved in these mechanisms.

IV. Response to stimulus

Respond to Changes in environment

- E.g. Amoeba moving away from light

  Some animals hibernating when winter arrives

V. Growth and Development

- **Growth**: Result of cell division (formation of two cells from one) and cell enlargement (cells enlarge as they mature)

- **Development**: Maturation

  Single cell → Cell cluster → Differentiation (specialization)

VI. Reproduction & Heredity

- Reproduction, Replication

- **Asexual** reproduction: e.g. cell division in bacteria
- **Sexual** reproduction: Fusion of male and female gametes.

  E.g. egg and sperm in animals

  pollen and ovule in plants

  - Viruses: can only reproduce in their hosts

Heredity

Transfer of genetic information from parent to offspring during reproduction

i.e. transfer of *genes*

- In asexual reproduction, the offspring gets the exact copies of the parent

Some interesting reproductive strategies

- Many female birds, rabbits and reptiles can store sperm for months
- Females of many species, including some mantises and spiders, feed on the male immediately after mating
- Some fish can switch sex in days

Photo: Nick Hobgood/Wikimedia

Photo: Oliver Koemmerling/Wikimedia

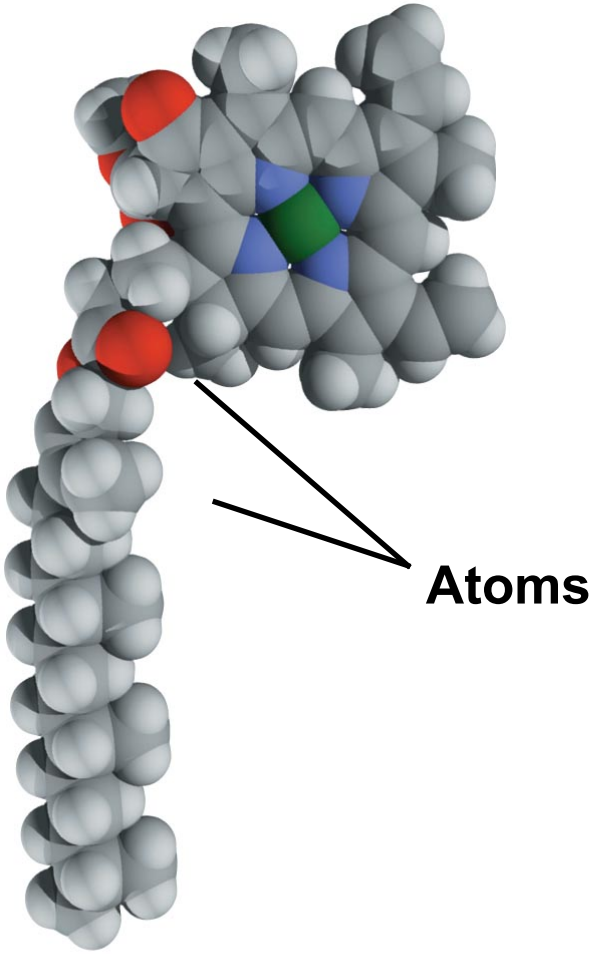
VII. Evolution

- Evolution ~ change

- *Biological evolution*, loosely speaking, is change in groups of organisms over the course of generations

- **Adaptations** are the result of evolution

Scales of biology



Molecules

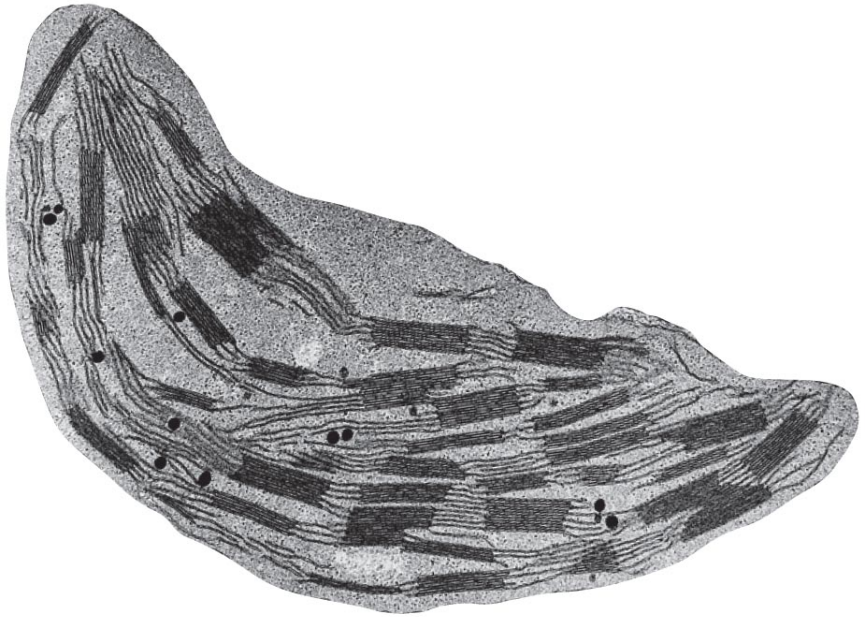
H_2O

O_2

O_3

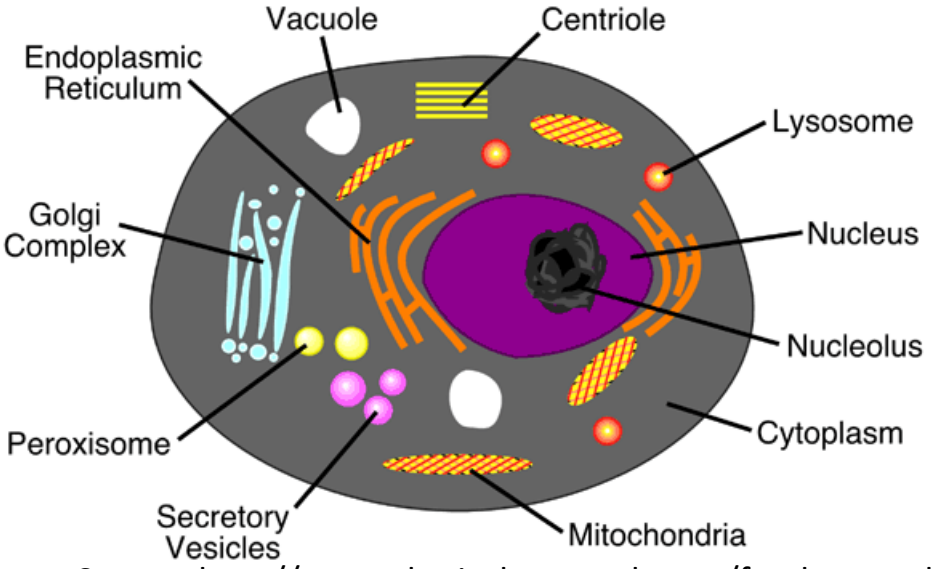
Organelles (subunits of Cells)

(e.g. Chloroplast - photosynthesis)



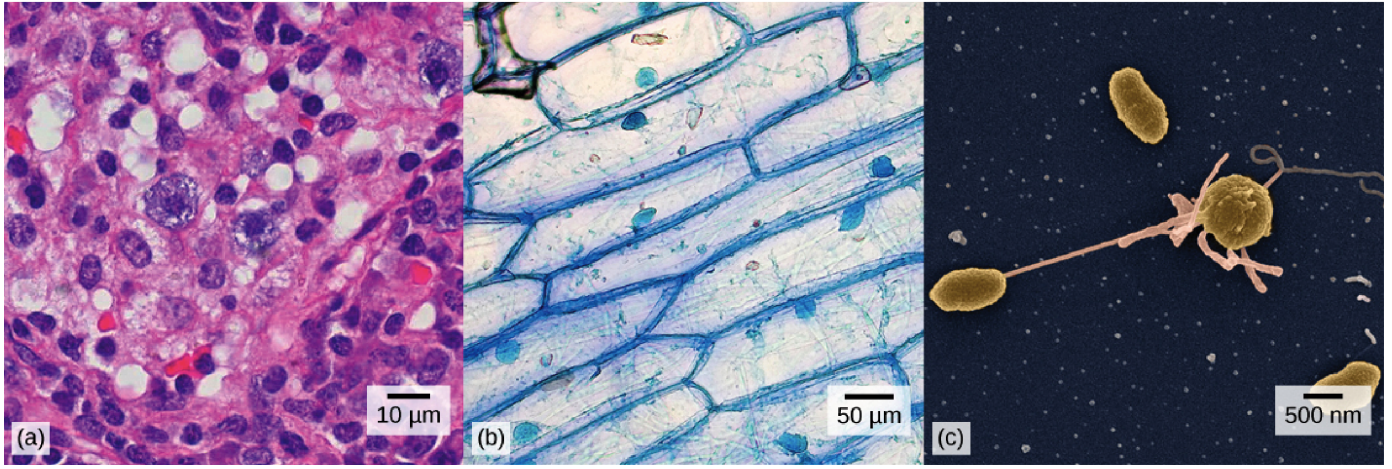
Cells

- basic building blocks of life



Source: http://www.physicalgeography.net/fundamentals/6a.html

Human sinus cells | Onion cells | Bacterial cells



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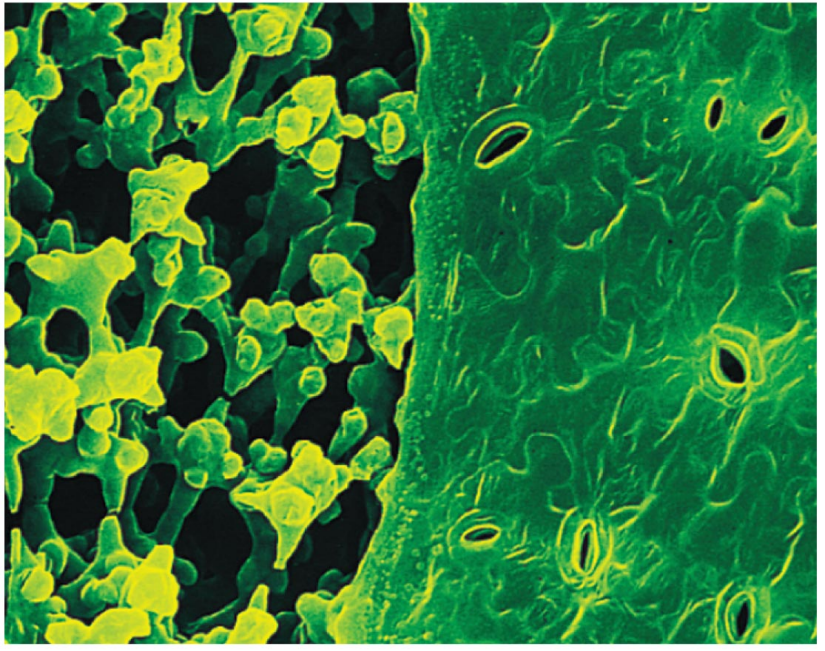
Tissues - group of similar cells with a common function

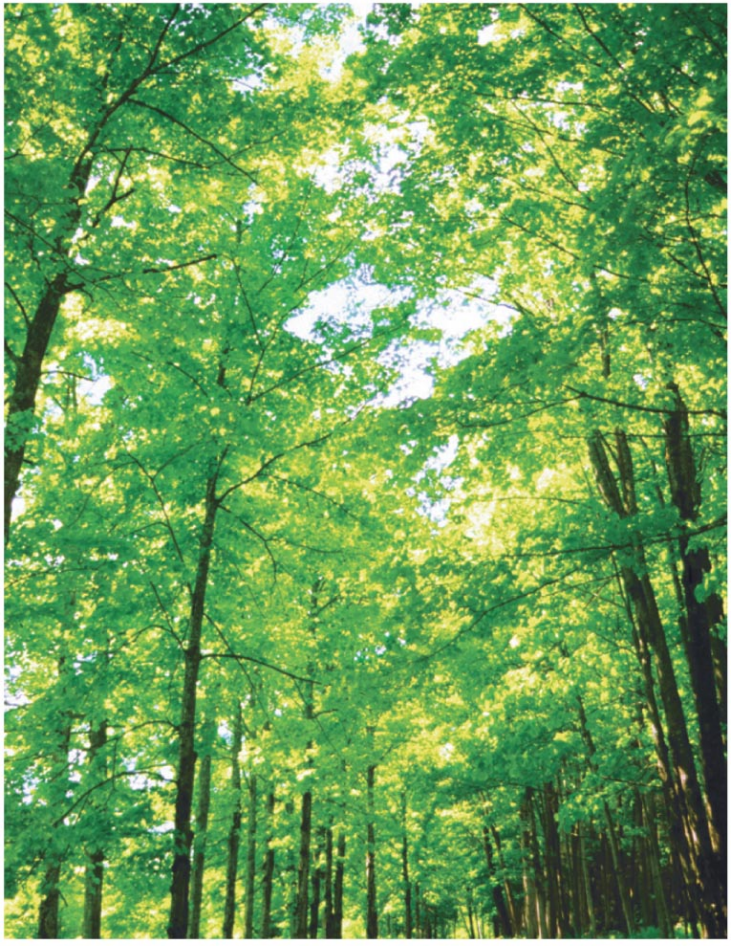


50 µm

Organs

Organisms (Individuals)

Populations – All individuals of a species living in an area)



Community - Populations of all species in an area

Ecosystems - Community AND non-living environment

Environment

- Biotic – living things
- Abiotic – non-living matter

The biosphere

Zone of life on earth.
Sum of all ecosystems

Scales of Life