

BB101
General Introduction to Biology

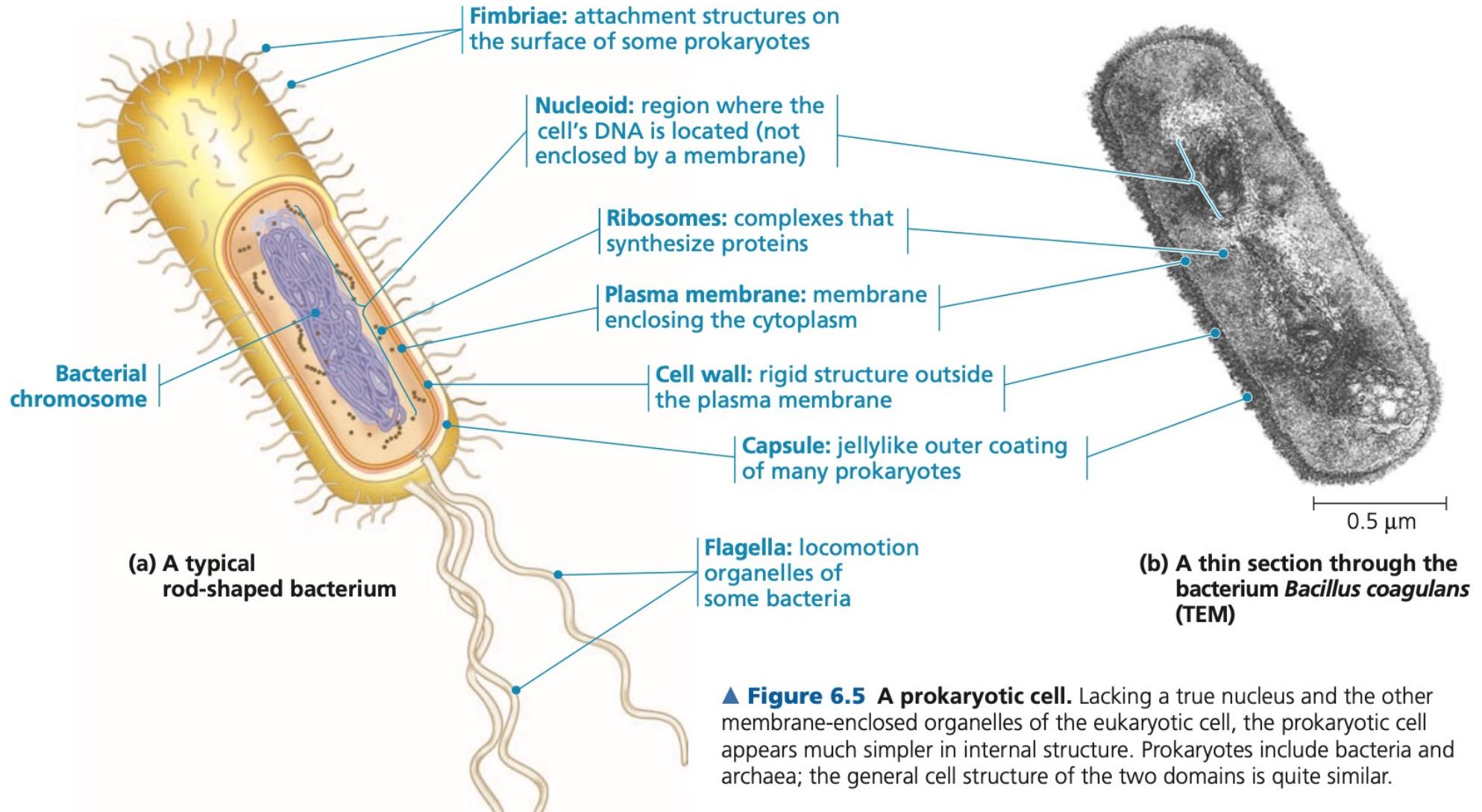
Tutorial 1
(SS-T1)
Introduction

11 January 2024

The functional unit of life: Cell

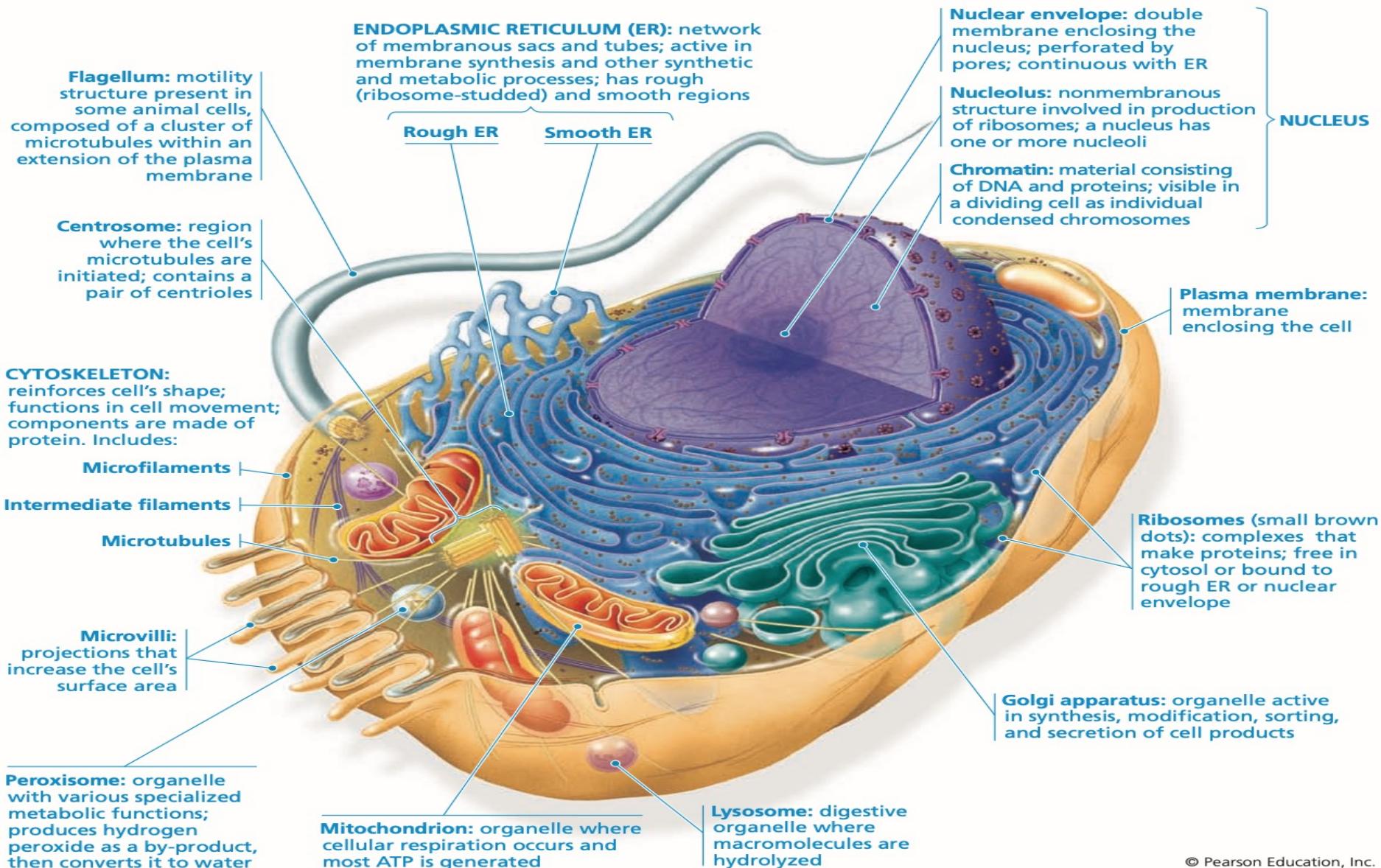
- Prokaryotic cell
- Eukaryotic cell

Prokaryotic Cell



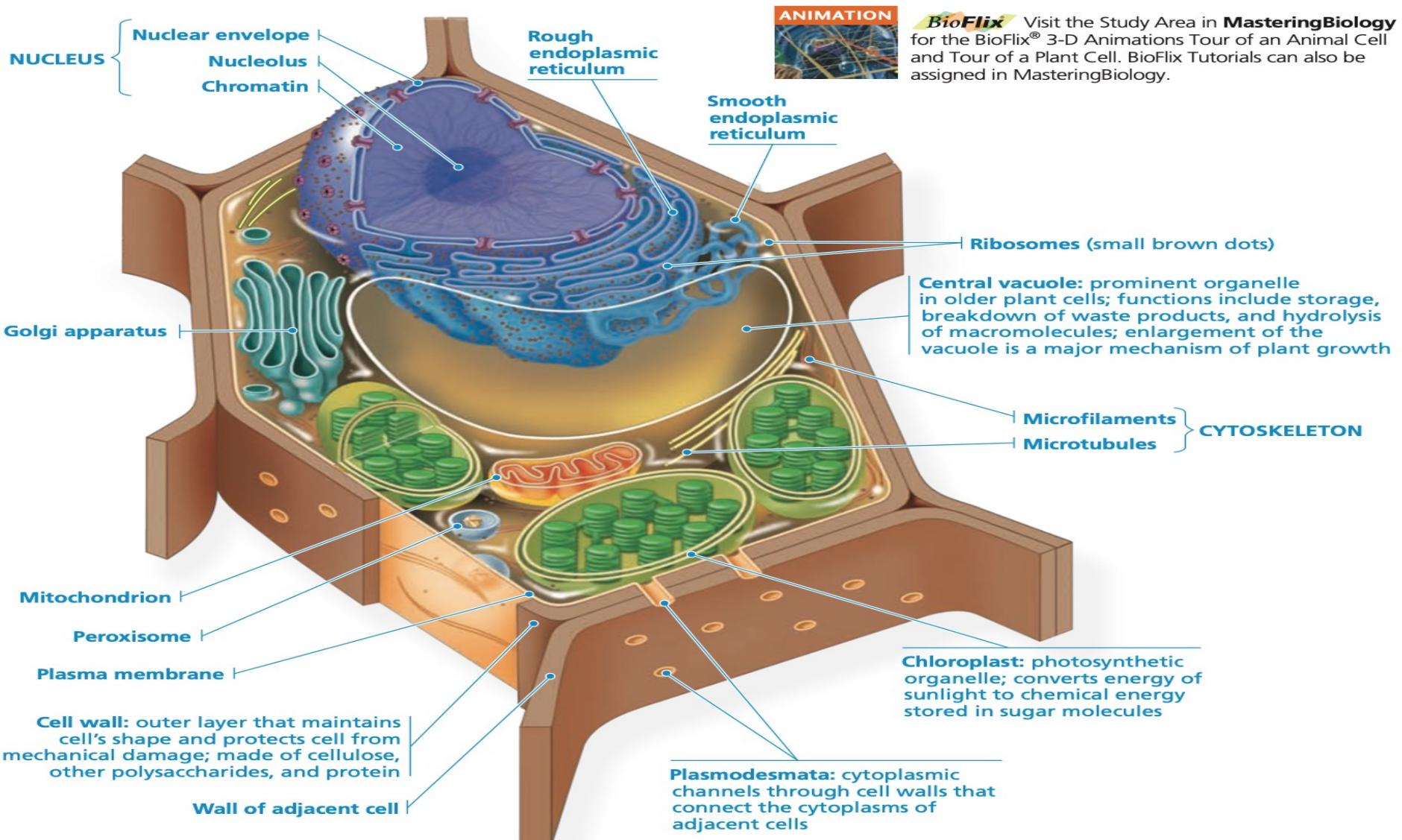
Eukaryotic Cell

Animal Cell (cutaway view of generalized cell)



Eukaryotic Cell

Plant Cell (cutaway view of generalized cell)



Biological Macromolecules

Life depends on **four** types of organic macromolecules:

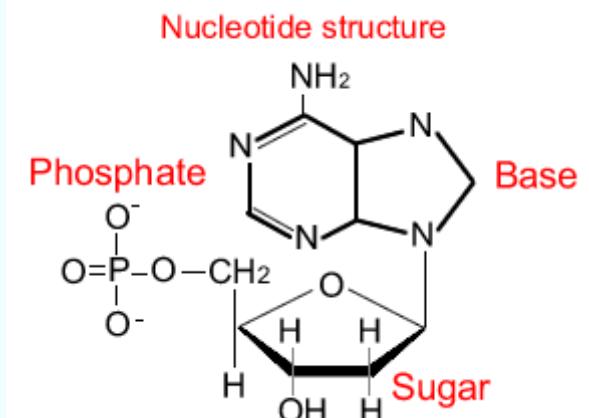
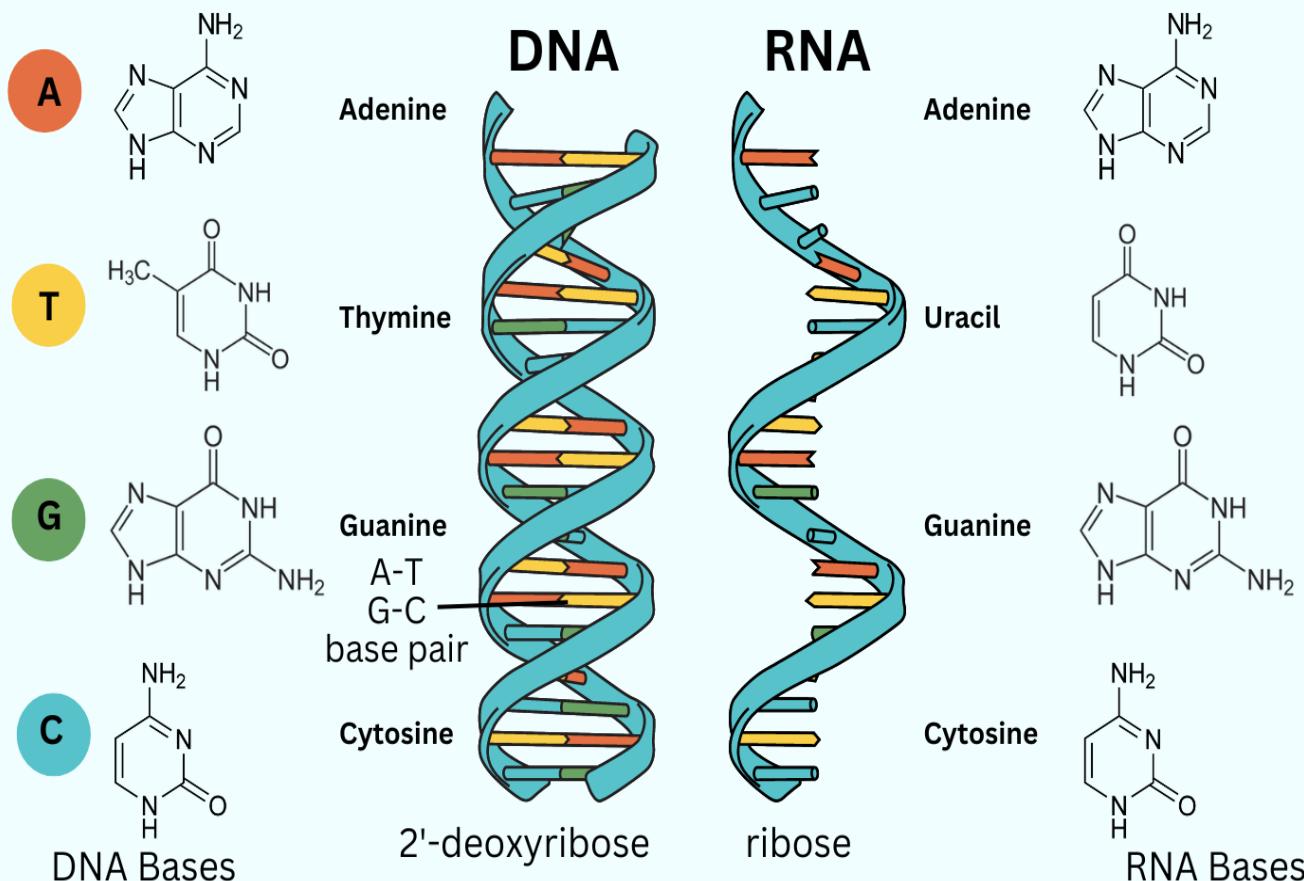
1. Nucleic acids
2. Proteins
3. Lipids
4. Carbohydrates

Nucleic Acids

Nucleic Acids

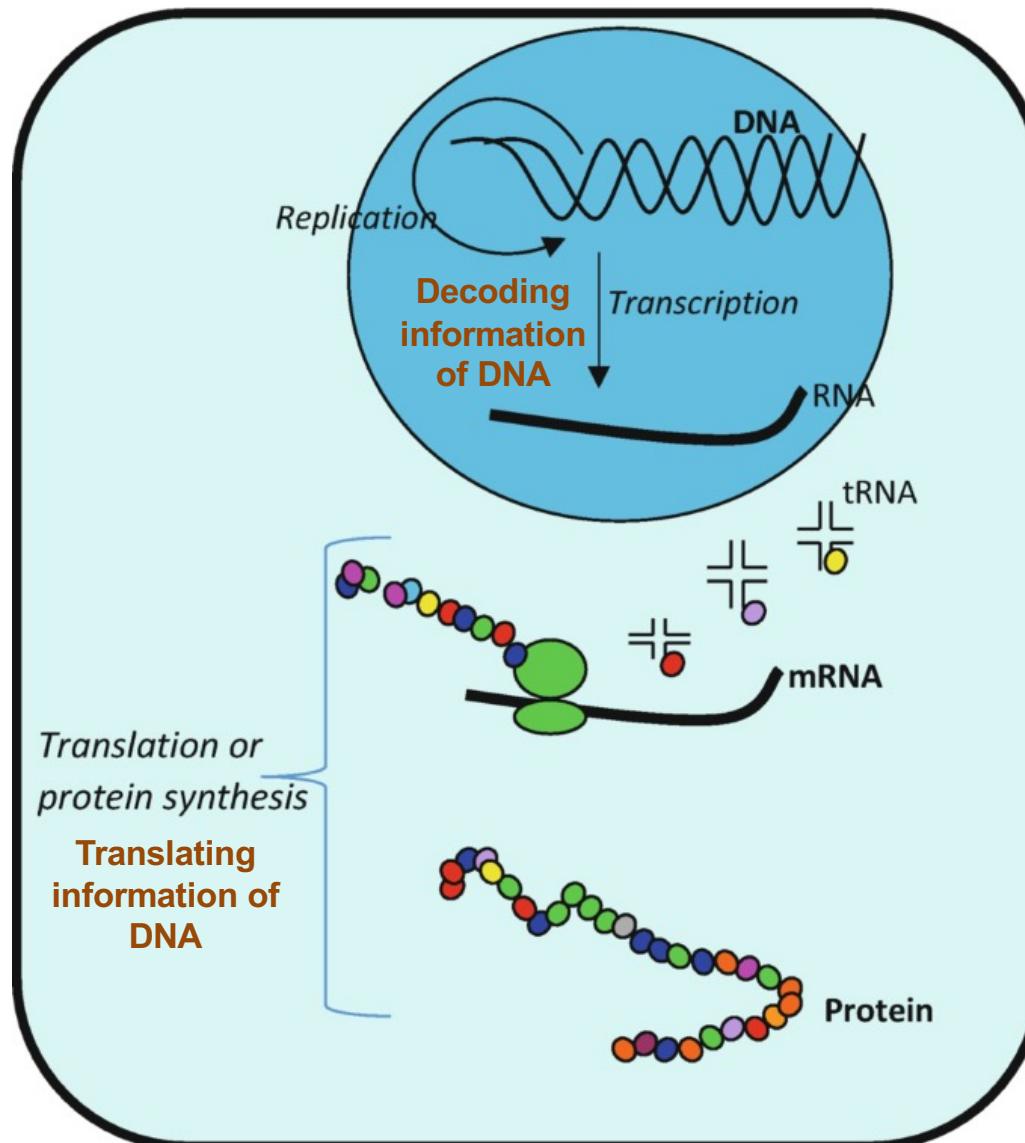
The two classes of nucleic acids are DNA and RNA.

scienzenotes.org



Why named so?

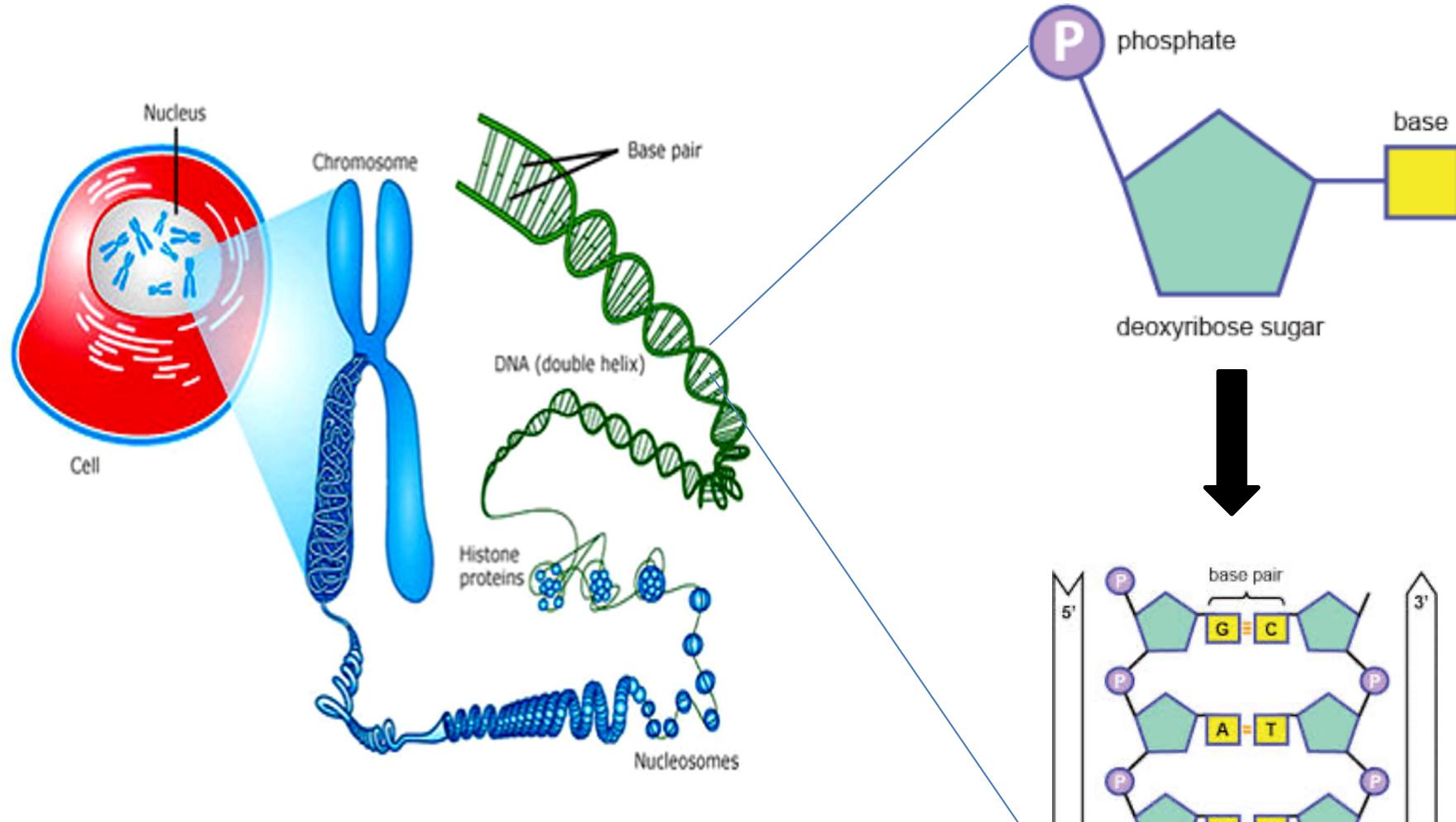
Central Dogma of Cell



https://doi.org/10.1007/978-3-031-37192-9_3

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Deoxyribonucleic Acid (DNA)



Fun fact: Do you know what is the total length of DNA in our body?

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Interesting Facts about DNA Sequence



Unrelated people



Man and chimpanzee (>95%)



Man and cabbage (>50%)

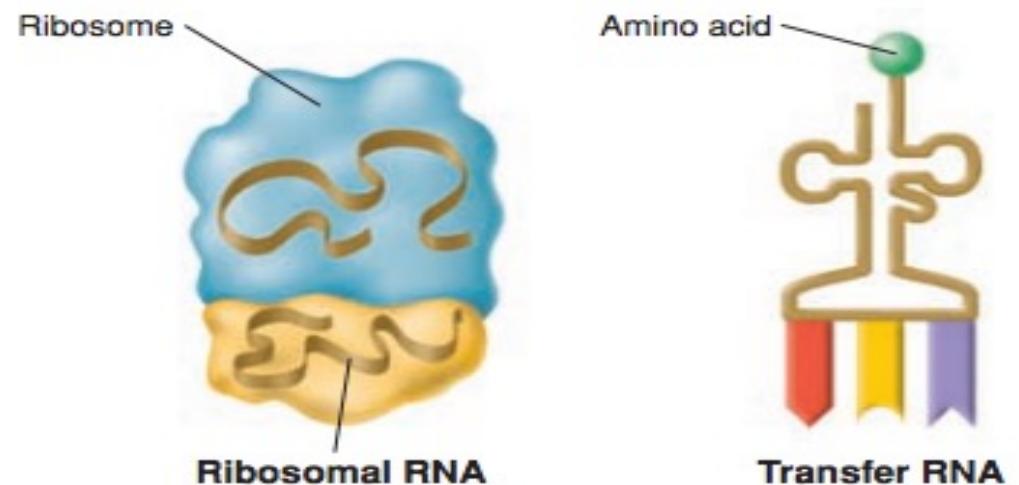
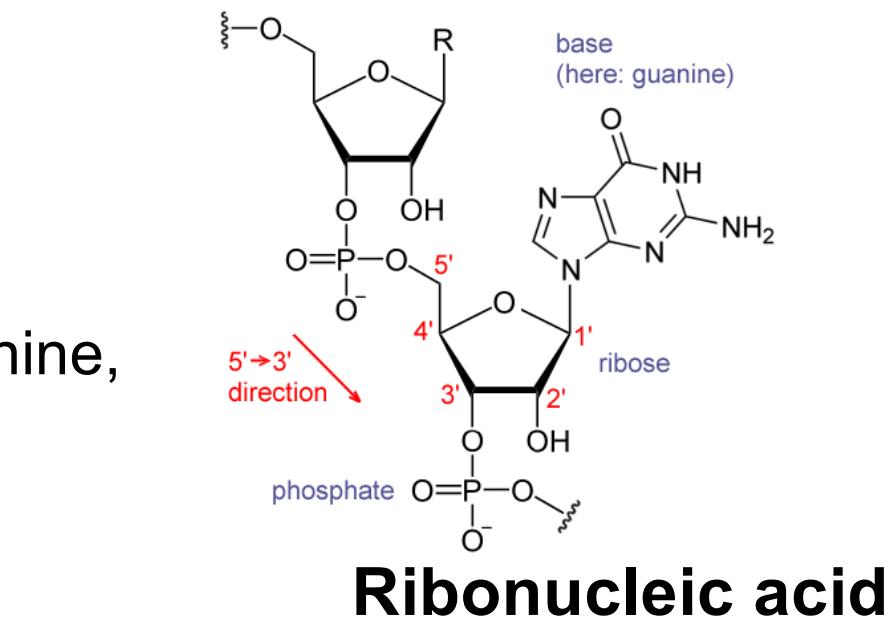
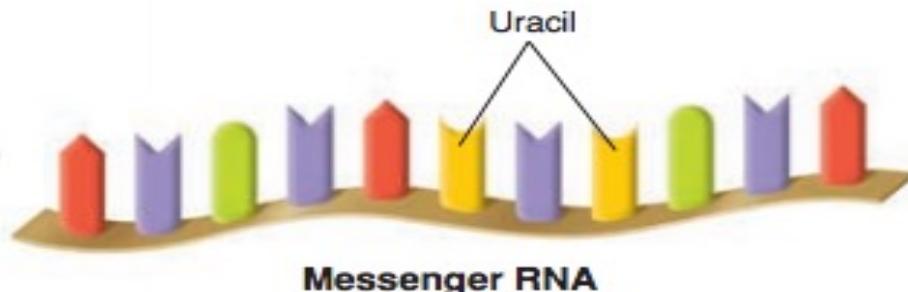


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Ribonucleic Acid (RNA)

- Polymer of ribonucleotides
- Usually, single stranded
- Bases: guanine, uracil, adenine, and cytosine
- Synthesized by transcription

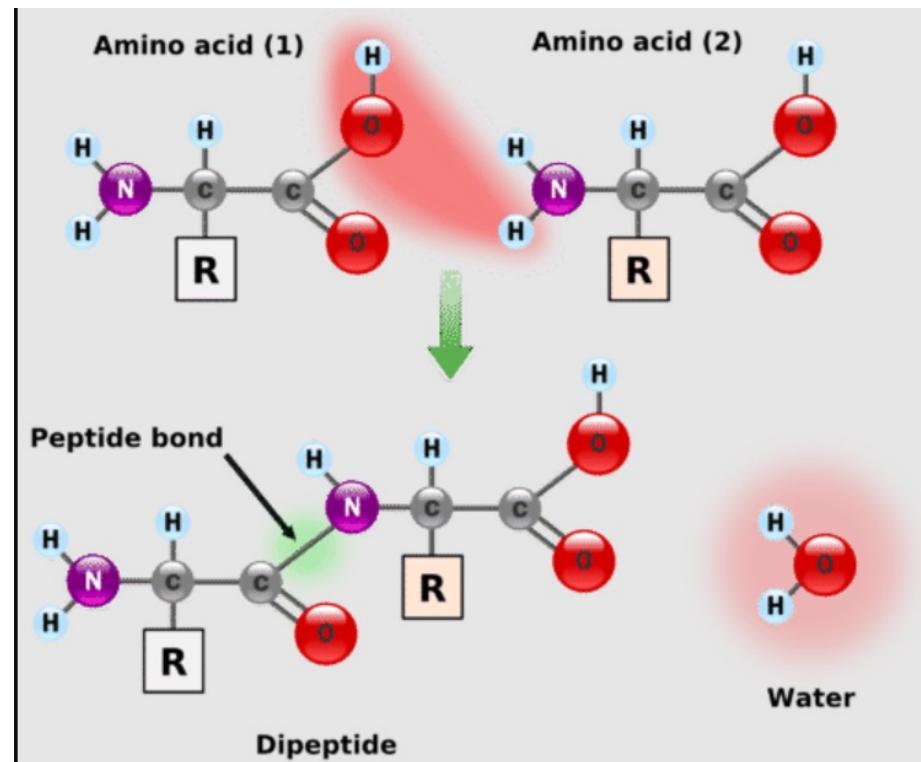
Types of RNA



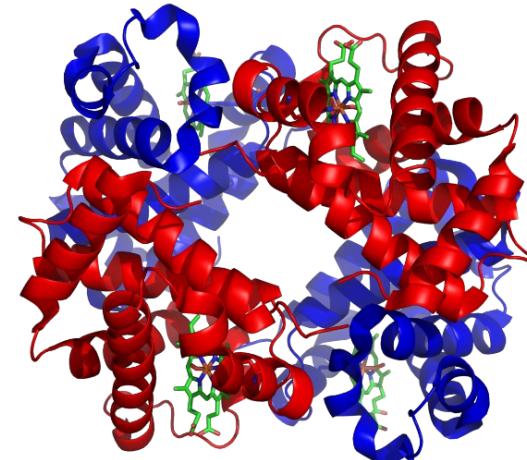
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Proteins?

- Large molecules
- Made of amino acids
- Two amino acids are linked by peptide bond
- **Body's functions – workhorses of cell**
- Sequence is determined by DNA
- Structure is crucial for function



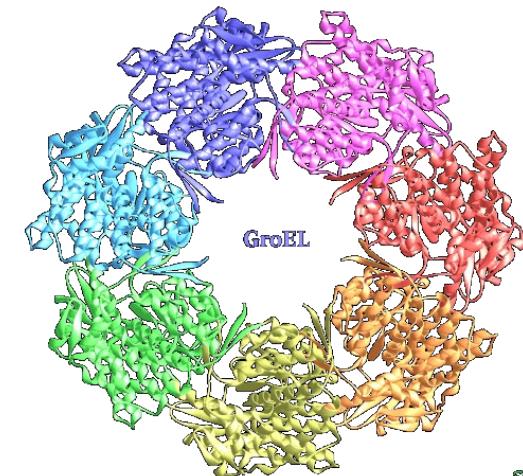
Protein Structure



Source – Wikipedia

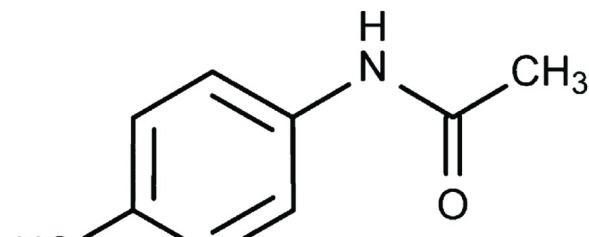


Source – RCSB PDB

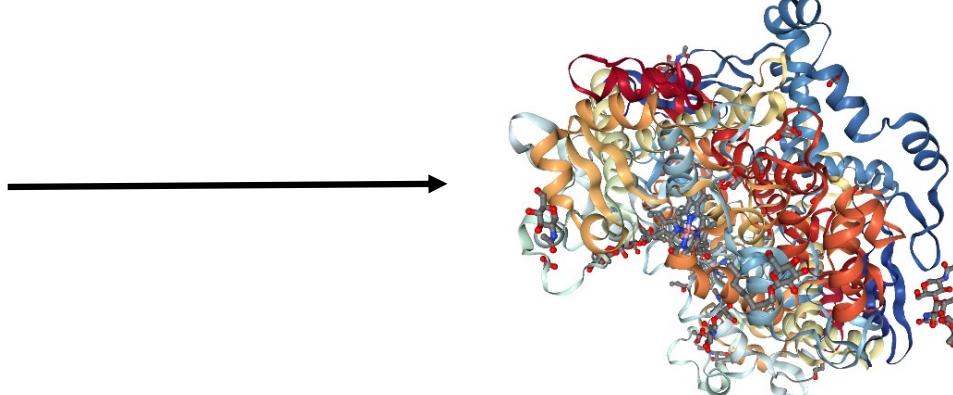


Source – Online Analysis Tools

Drugs – More than 70% of drugs have proteins as their target



Paracetamol



COX2

Source – RCSB PDB

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Protein Structure Prediction Using AI



Proteins are complex molecules that are essential to life. Each has its own unique 3D shape that determines how it works and what it does.

Knowing how proteins fold could help scientists understand the biological processes of every living thing. To accelerate progress, we created AlphaFold, a system which accurately predicts the shape of proteins. This research has enormous potential in every field of biology, from helping tackle disease and quickly finding new medicines to unlocking the mysteries of how life itself works.

Carbohydrates

Carbohydrates: Monomers and polymers of sugar

Polymers

(Energy storage,
structural blocks)

\leftrightarrow

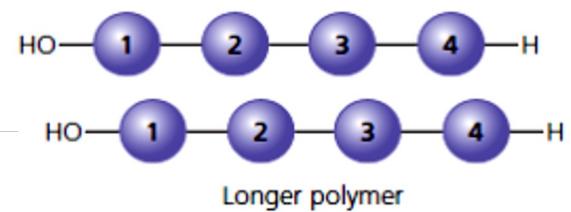
Monomers

(Readily available
Energy forms)



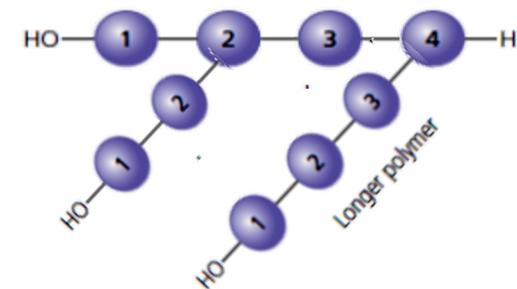
**Primary production
(Polymers formation)**

Plants



**Hydrolysis (Monomerization)
Digestion by animals**

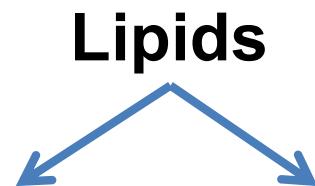
**Dehydration (polymerization)
Re-Building structural &
functional blocks**



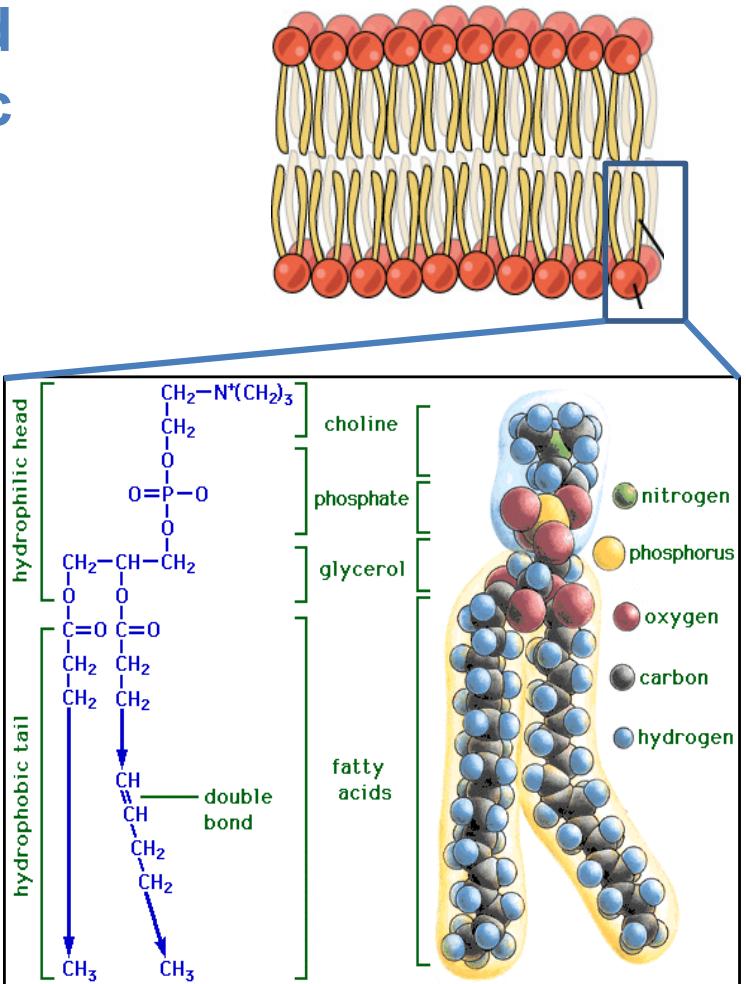
Lipids

Lipids: Organic biomolecules grouped together based on their hydrophobic trait.

- Energy storage and Structural roles.
- Chains ranging from C₄-C₃₆.



Structural roles: Energy storage:
eg: Phospholipids eg: Triglycerides



Why Lipids as Storage?



1 g Carbohydrates = 4.0 kcal

1 g Fat = 9.0 kcal

Less weight with more Energy storage

Cell Division

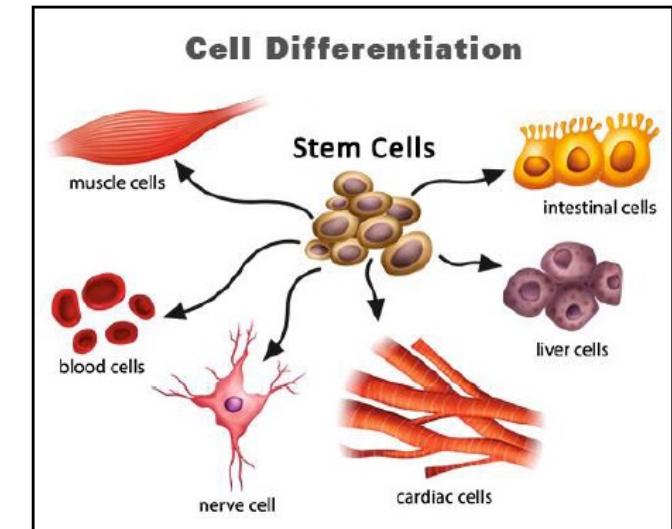
GROWTH



REPAIR



DIFFERENTIATION



Types of Cell Division:

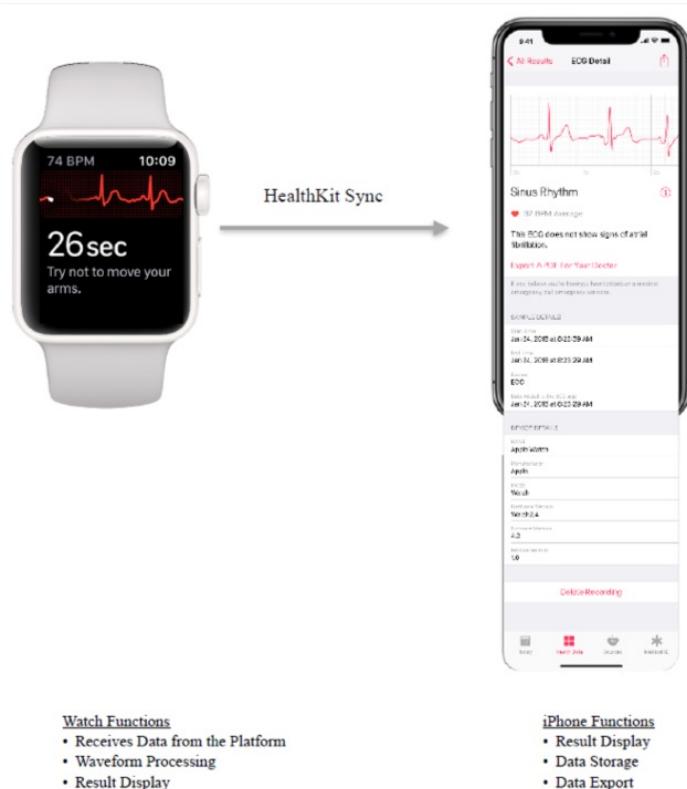
1. Mitosis
2. Meiosis

Real Life Applications of Biology

Biology: Overcoming Health Challenges

Forbes

Apple Watch 4 Is Now An FDA Class 2 Medical Device: Detects Falls, Irregular Heart Rhythm



HEALTHCARE ON YOUR WRIST



cardiogram

Consumer wearables like Android Wear, Fitbit, and Apple Watch will generate two trillion health measurements this year—far too many for any human doctor to review. To help create the future of preventive medicine, we're building DeepHeart, a novel deep neural network tested in multiple rigorous clinical studies.

- Cardiovascular Risk Prediction
- Abnormal heart rhythm – Atrial fibrillation
- Hypertension, Sleep Apnea

What the future looks like?

- Glucose monitoring
- Blood Pressure
- Oxygen Levels
- Parkinson's disease diagnosis and monitoring
- Respiration Rate

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Biology: Overcoming Health Challenges



NEURAL ENGINEERING | NEWS

Brain-computer interface that allowed a paralysed man to walk is the *Physics World* 2023 Breakthrough of the Year

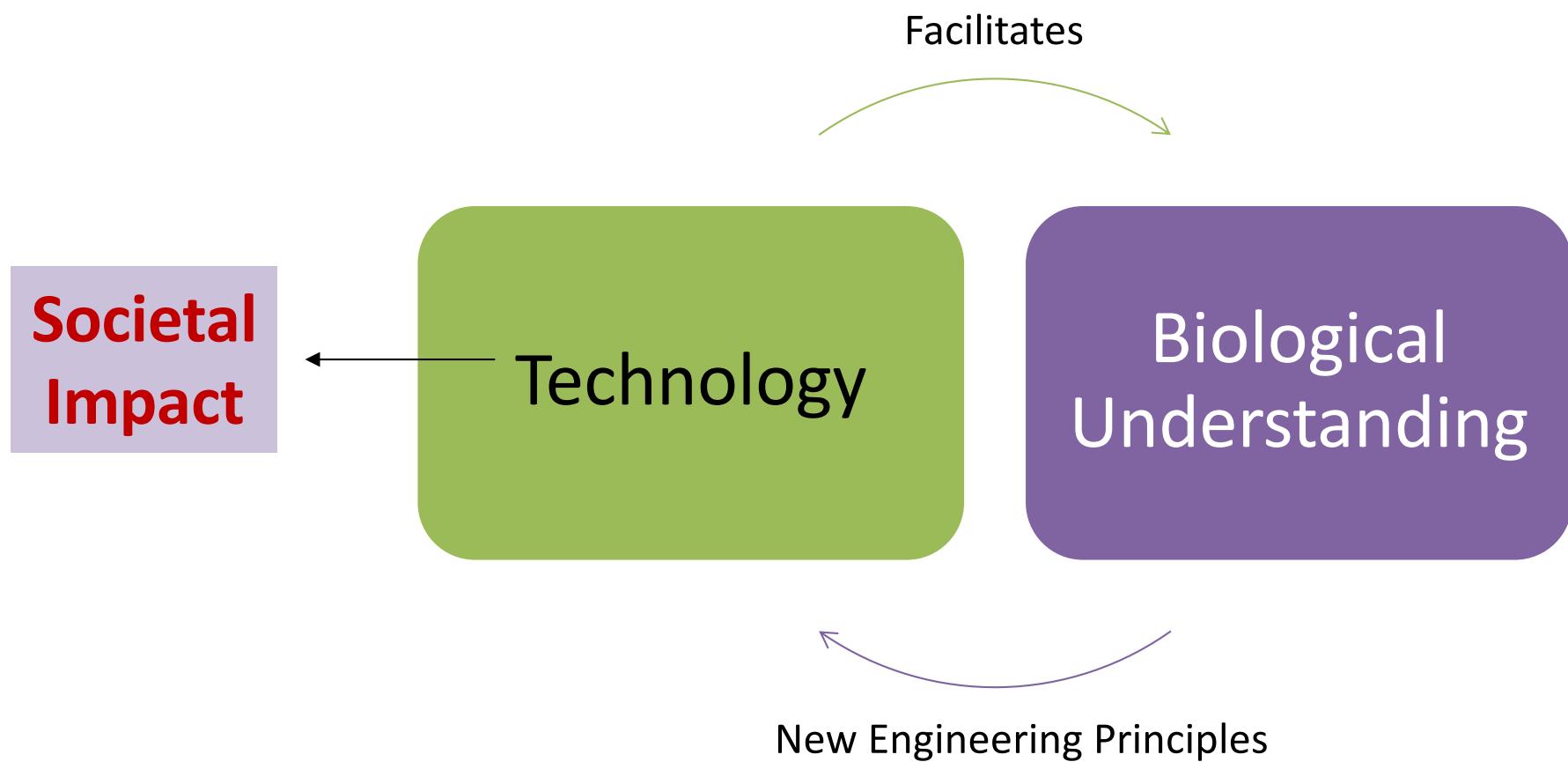
- A digital bridge that restores communication between the brain and spinal cord.
- When tested on a man with paralysis, the system enabled him to stand and walk naturally



Gert-Jan Oskam is able to walk on his own, thanks to the new technology that interprets messages from his brain | CREDIT: Ecole Polytechnique Federale de Lausanne

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Partnership Between Biology and Technology



Take home!

"One of the very few silver linings about me getting sick is that Reed's gotten to spend a lot of time studying with some very good doctors... I think the biggest innovations of the twenty-first century will be the intersection of biology and technology. A new era is beginning, just like the digital one when I was his age."

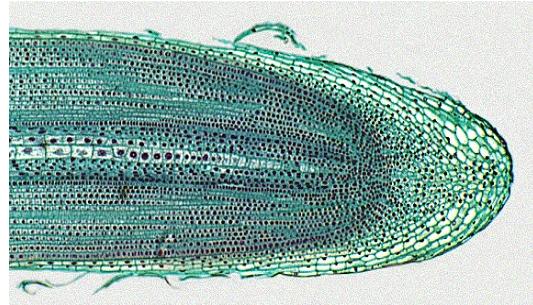
Steve Jobs

Thank You

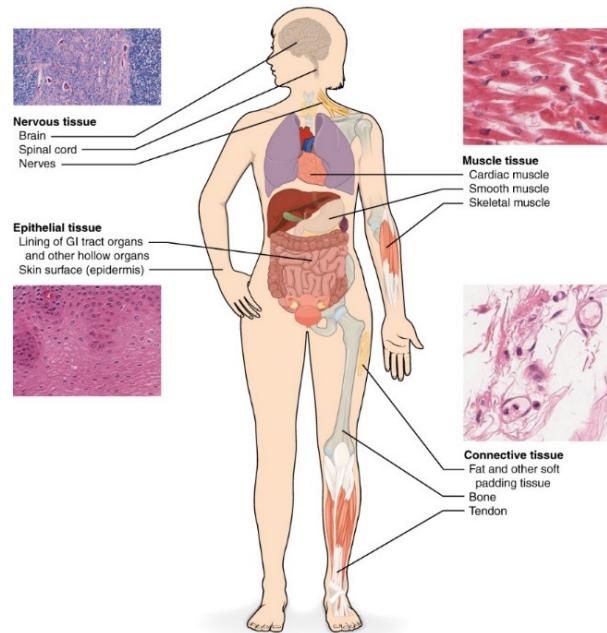
Concepts and Queries



Why bother with multi-cellularity? Why not one large cell?

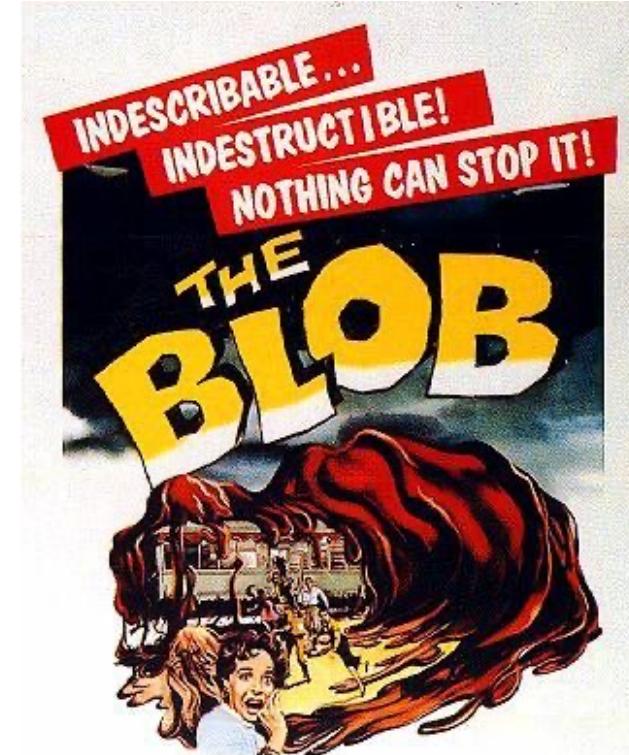


Cross section of a root tip



Human body consisting of organs, tissues and cells

VERSUS



Natural laws limit cell size

At a minimum, a cell must contain enough volume to house the parts it needs to survive and reproduce

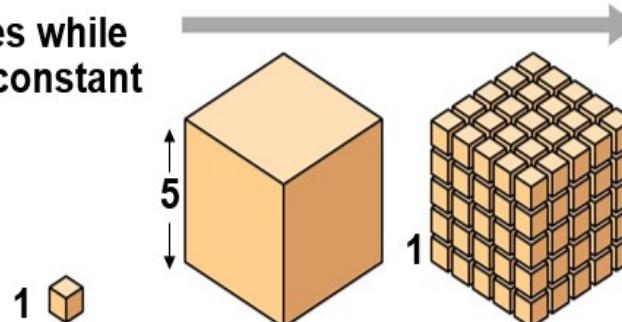
The maximum size of a cell is limited by the amount of surface area needed to obtain nutrients from the environment and dispose of wastes

Surface area relative to the volume decreases as the size of a cell increases.
- limits the size of cells



Natural laws limit cell size

Surface area increases while total volume remains constant



Helps in efficient exchange of heat and matter

Total surface area
[sum of the surface areas (height \times width) of all box sides \times number of boxes]

6

150

750

Total volume
[height \times width \times length \times number of boxes]

1

125

125

Surface-to-volume (S-to-V) ratio
[surface area \div volume]

6

1.2

6

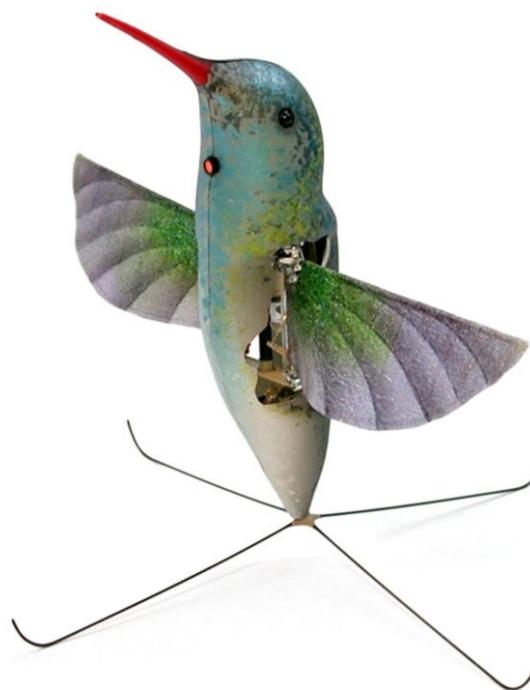
A larger organism does NOT mean larger cells; just more cells; size of the cell remains pretty much the same

Biomimicry : VELCRO



- Created in the 1940s by Swiss Engineer George de Mestral, VELCRO is one of the best-known examples of biomimicry. While hiking, de Mestral noticed that the hook-like structure of burdock burrs allowed the seed pods to stick to his dog's fur.
- The prickly seed burrs from the plants clung to his clothing and to his dog. While pulling off the burrs he noticed how they were removable yet easily reattached.
- He studied the burrs under a microscope and discovered a hook system used by the burdock plant to migrate its seeds by attachment. The hooks could grab onto loops of thread or fur. This gave him the idea of creating a hook and loop fastener.

Are bioinspired drones the next big thing in unmanned flight?



- Can you think of animals from which drones can be inspired?
- Can you think of advantages of such bio-inspired drone?



Length of DNA



Calculate the total length of DNA?

The haploid genome contains ~ 3 billion base pairs.

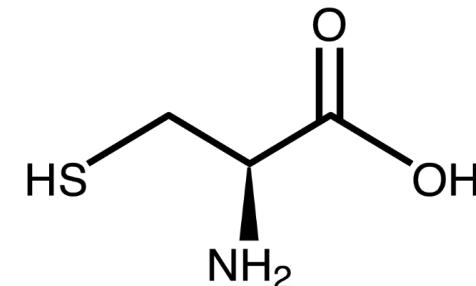
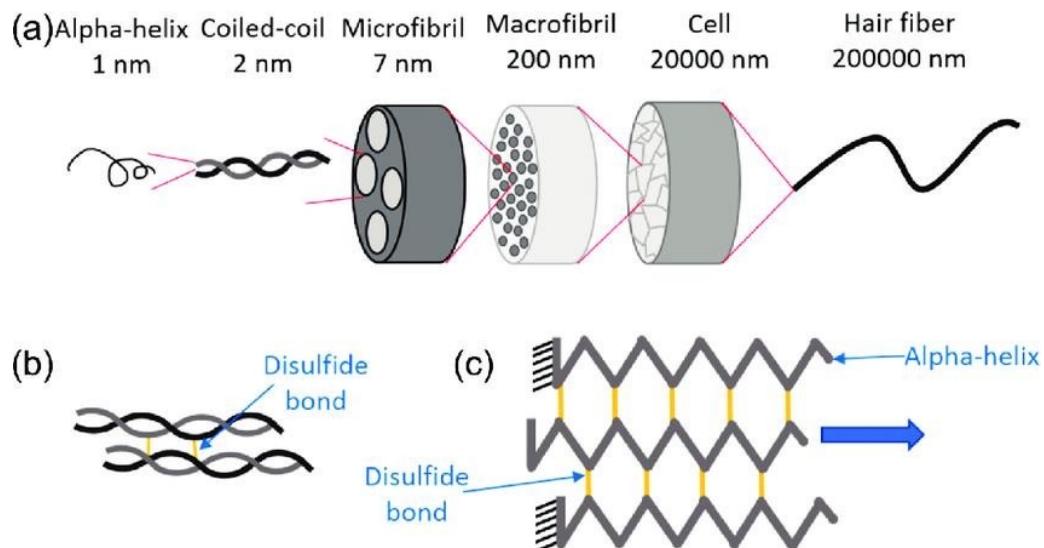
Humans are diploid – i.e., each cell contains two copies of each of the 23 chromosomes.

Distance between two adjacent base pairs – 0.34nm.

Total number of cells in human body – More than 30 trillion

The Biochemistry behind Hair Straightening

Hair is made up of protein called **keratin**



Keratin is rich in Sulphur-containing amino acid – cysteine.

Texture of the hair is due to disulphide and hydrogen bonds.

Q. How can you make a new hair straightening formulation?

Hint: Disulfide bonds

Scan this for a surprise!!!

