
The cytology
22-feb-2021
First lecture
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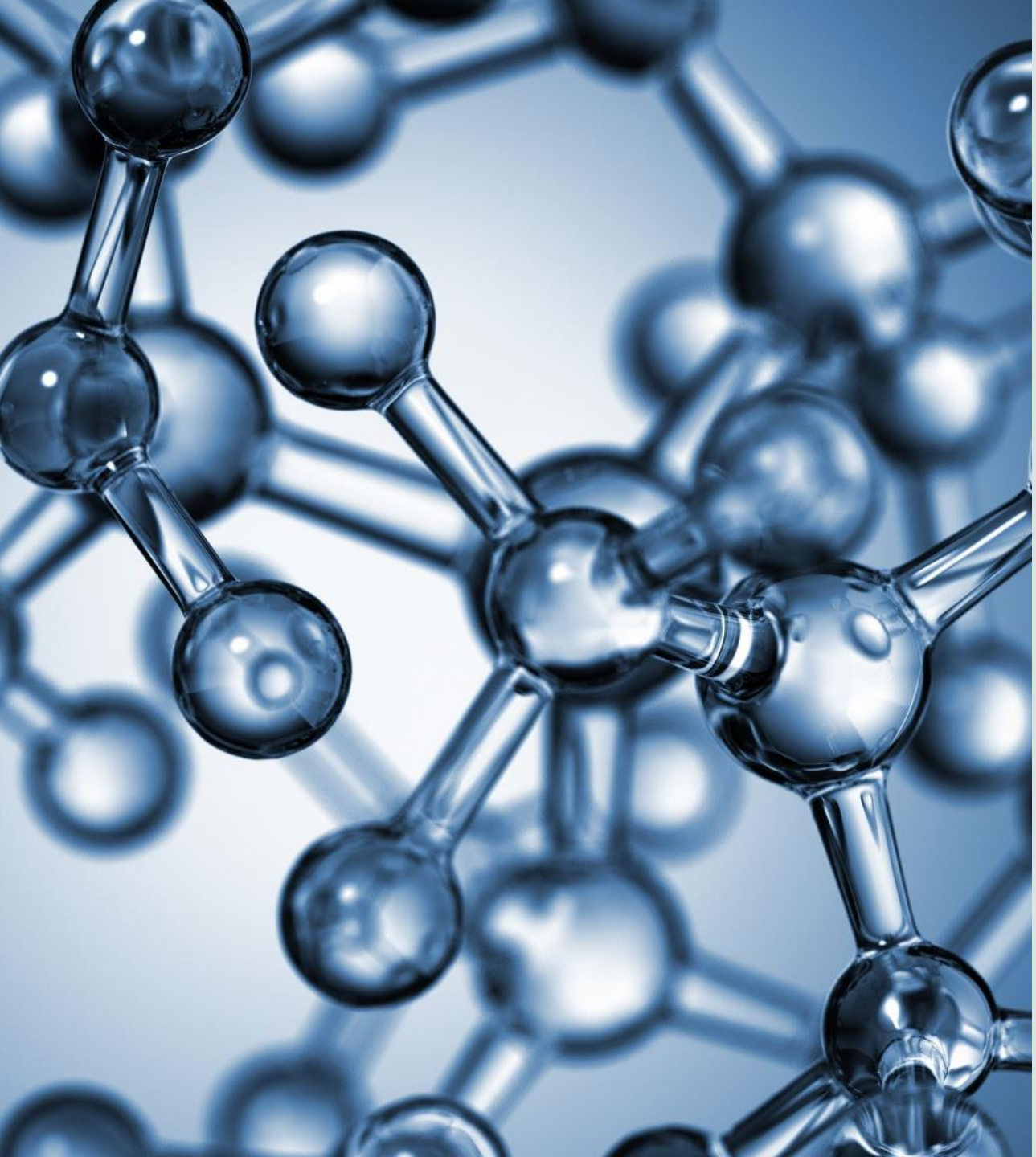
1.0 | Introduction We Are Cells

The cells are the building unites in the body so all organs are made by one or more cells which build the tissues and tissues make an organ and a group of organs make a system which has a specific function (the origin of life corresponds to the origin of cell) .

The body grows by adding new cells in the cellular division and this is the way by which we grow from a tiny embryo into a large adult .

Medicine use cells to cure disease in two ways : using the cells themselves or changing the way in which the cells behave .



- The science of cell is extremely intense , it requires creative and advanced instrument and techniques , such as microscopes .
- Cell biology is reductionist, based on the premise that studying the parts of the whole can explain the character of the whole.

إن بيولوجيا الخلية اختزالية ، تستند إلى فرضية أن دراسة أجزاء الكل يمكن أن تفسر طبيعة الكل

1.1 | The Discovery of Cells Microscopy

i. The microscope was first invented by Robert Hooke and Anton Leewenhoek did its refinement . اكتشفه هوك وعدله ليوينهوك

ii. The cells were discovered after this invention .

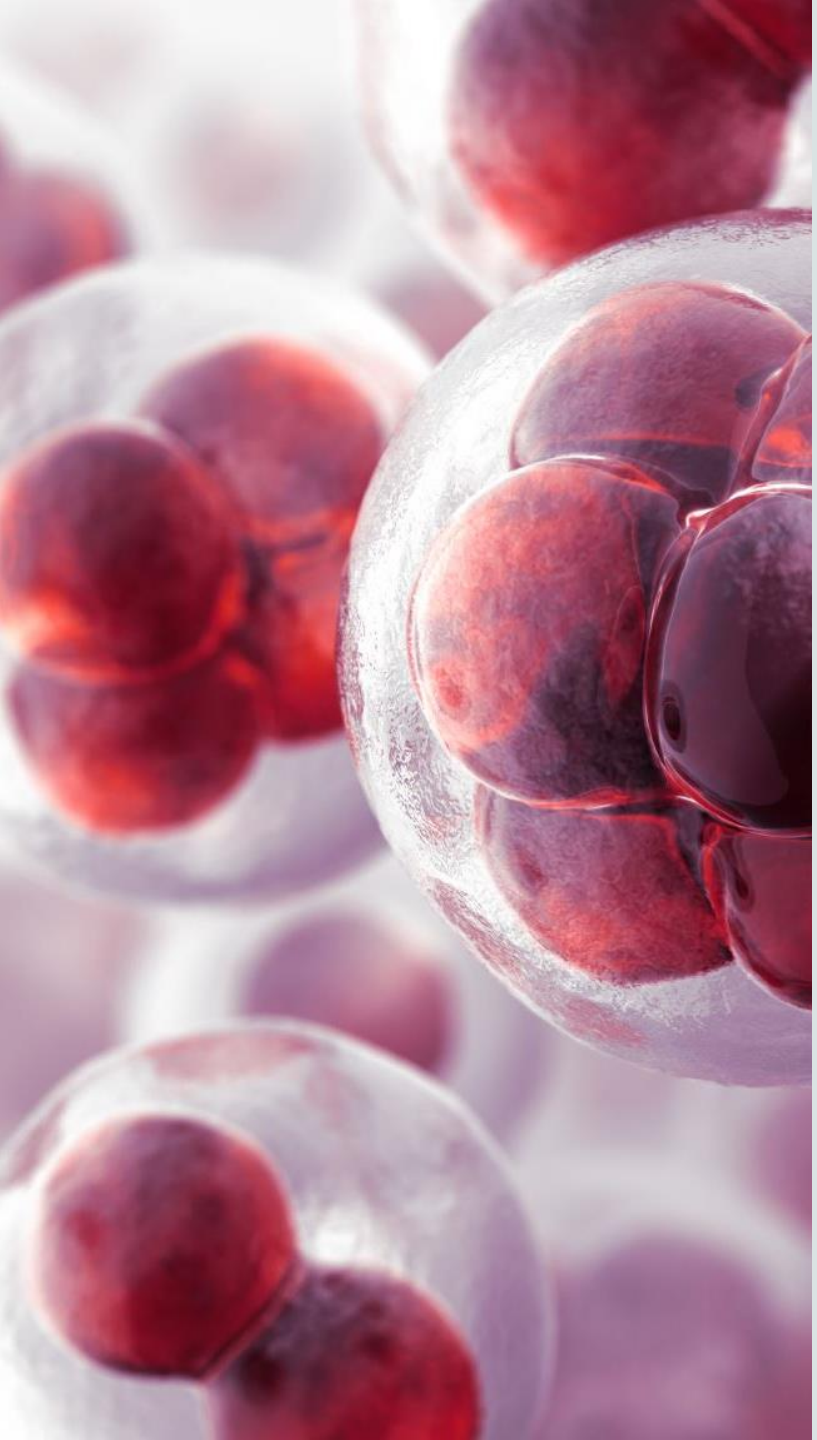
iii. Hooke termed the pores inside cork cells because they reminded him of the cells inhabited by monks living in a monastery.

جاءت قام هوك بتسمية مسام الفلين بالخلايا لانها تذكره بالخلايا التي يسكنها الرهبان بالدير و من هنا تسمية الخلايا

.....

Leewenhoek was the first one to examine a drop of pore water under the microscope and observe the teeming microscopic —animalculesǁ that darted back and forth.

"الجزيئات الحيوانية"أول من قام بفحص قطرة من ماء البركة تحت المجهر وراقب كان لوينهوك التي تندفع ذهابًا وإيابًا المجهرية المزدحمة



1.1 | The Discovery of Cells Cell Theory

In the mid-1800s by *Matthias Schleiden*, *Theodor Schwann* and *Rudolf Virchow*

The Cell Theory was introduced with the following items :

1.All organisms are composed from one or more cells.

ممكن يتكون الجسم من خلية وحدة او اكثر

2.The cell is the structural unit of life.

زي ما حكينا بداية إنو الخلية هي الوحدة البنائية

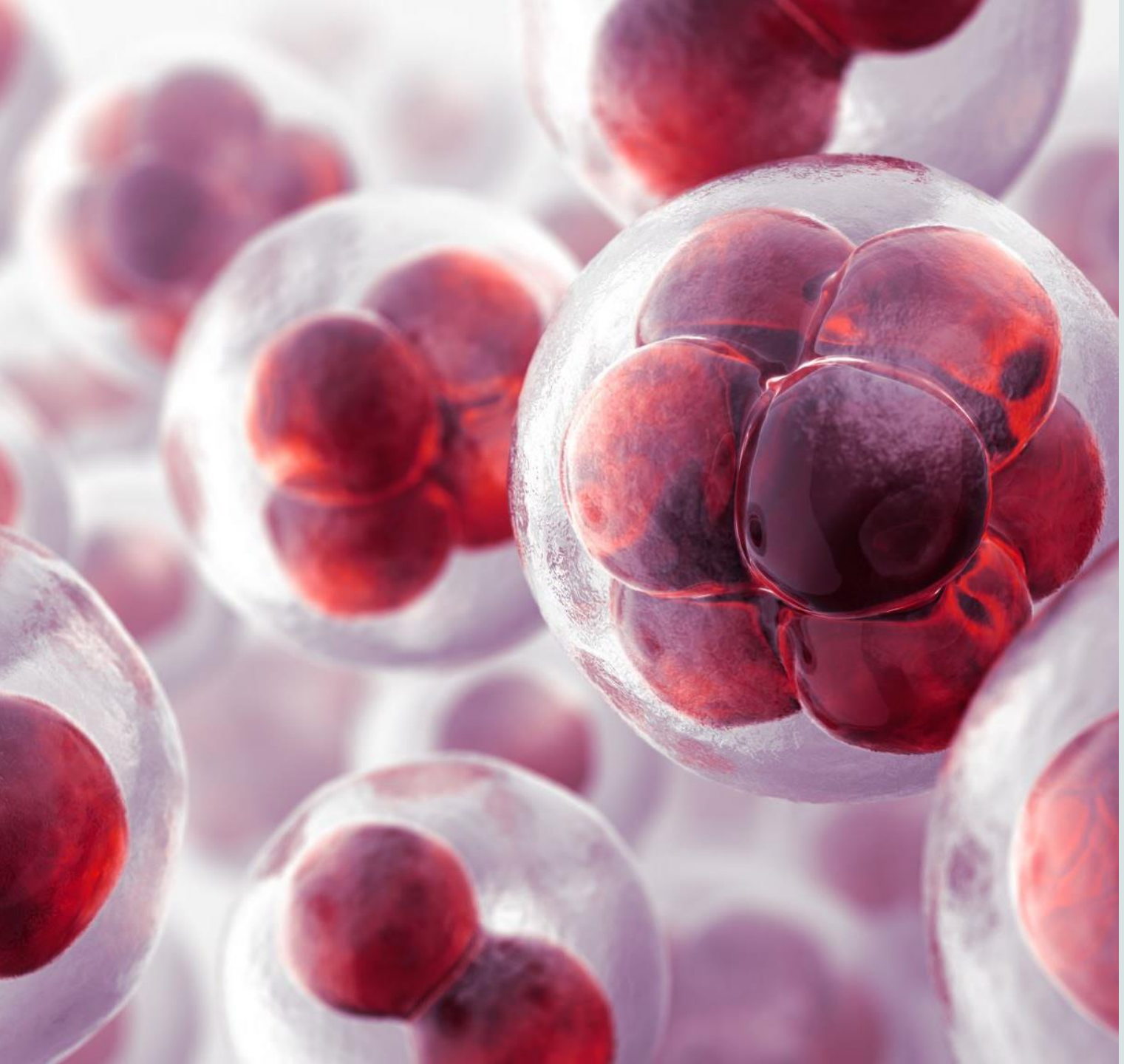
3.Cells arise only by division from a pre-existing cell.

الخلية بتتكاثر بالإنقسام من خلية سابقة

1.2 | Basic Properties of Cells
Cell Theory

- ***Life is the most basic property of cells***.
- The body still alive unless the cells died
- Cells can grow and reproduce in culture for extended periods eventually they die .
- HeLa cells are cultured tumor cells isolated from a cancer patient (Henrietta Lacks) by George and Martha Gey in 1951. They are immortalized cells .
- تعتبر هذه السلالة من الخلايا البشرية الأقدم والأكثر استخدام .هي سلالة خلايا خالدة تستخدم في البحث العلمي **هيلا**
- أكتوبر 4هنرييتا لاكس ، و هي كانت مريضة توفيت بعد استئصال خلايا السرطان في من 1951فبراير 8تم اشتقاقها من خلايا سرطان عنق الرحم المأخوذة في وجد المختصون في مستشفى باليتمور في ماريلاند بأن خلايا هنرييتا قوية وسريعة التكاثر بشكل ملحوظ، مما أدى إلى استخدامها على نطاق واسع في البحث .1951 العلمي
- ويكيبيديا :المصدر

Cultured cells are an essential tool for cell biologists .. it could be used in drugs discoveries , studying the chemical reactions inside the cells , etc .



1.2 | Basic Properties of Cells
Cells are Highly Complex and Organized

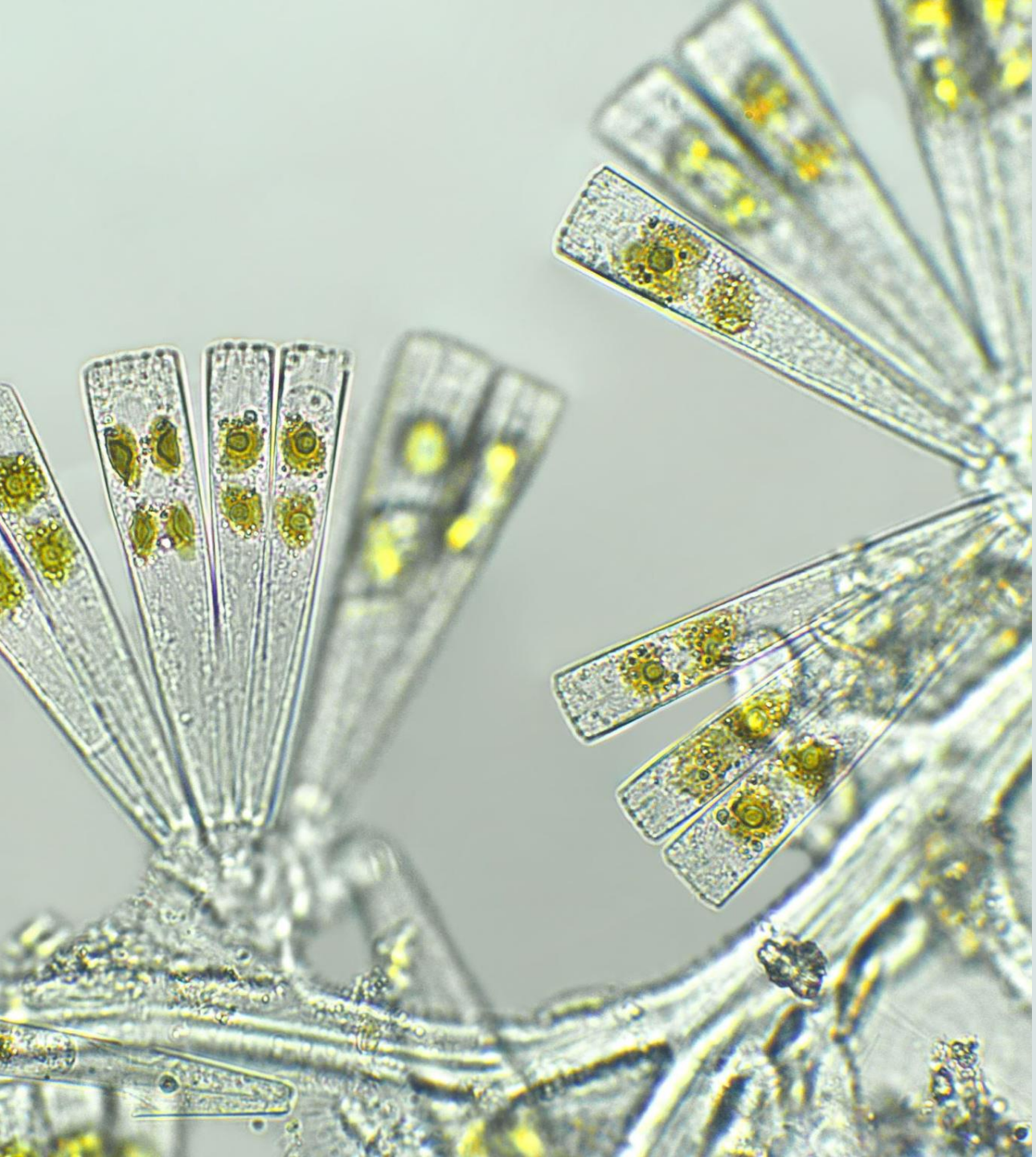
- Cellular processes are highly regulated ,all metabolic pathways , chemical changes and the cellular biochemistry are controlled and monitored by the cells .
- Cells from different species share similar structure, composition and metabolic features that have been conserved throughout evolution.

1.2 | Basic Properties of Cells
Cells Possess a Genetic Program and the Means to Use It

- Genes have a unique sequence of bases and this sequence represent the information that encoded in genes .This information is packaged into a set of chromosomes that occupies the space of a cell nucleus … By the transportation and translation these encoded information become a specific sequence of amino acids which indicate a specific protein for making more of themselves , run cellular activities and give the blueprints for constructing cellular structures .
- The molecular structure of genes allows for changes in genetic information (mutations) that lead to variation among individuals, which forms the basis of biological evolution.
- Mane of mutation are useful when they help the species in adaption with the new condition .

1.2 | Basic Properties of Cells
Cells Are Capable of Producing More of Themselves

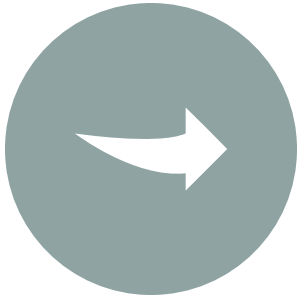
- Cells reproduce by **division**, a process in which the contents of a mother cell are distributed into two daughter cells with completely identical features .
- Before division, the genetic material is justly duplicated, and each daughter cell receives a complete , identical and equal share of genetic information DNA .



1.2 | Basic Properties of Cells
Cells Acquire and Utilize Energy

- Photosynthesis provides fuel (Glucose) for all living organisms , this process consumes ATP .
- Converting the light energy into chemical energy
- Animal cells derive energy from the products of photosynthesis, mainly in the form of glucose.

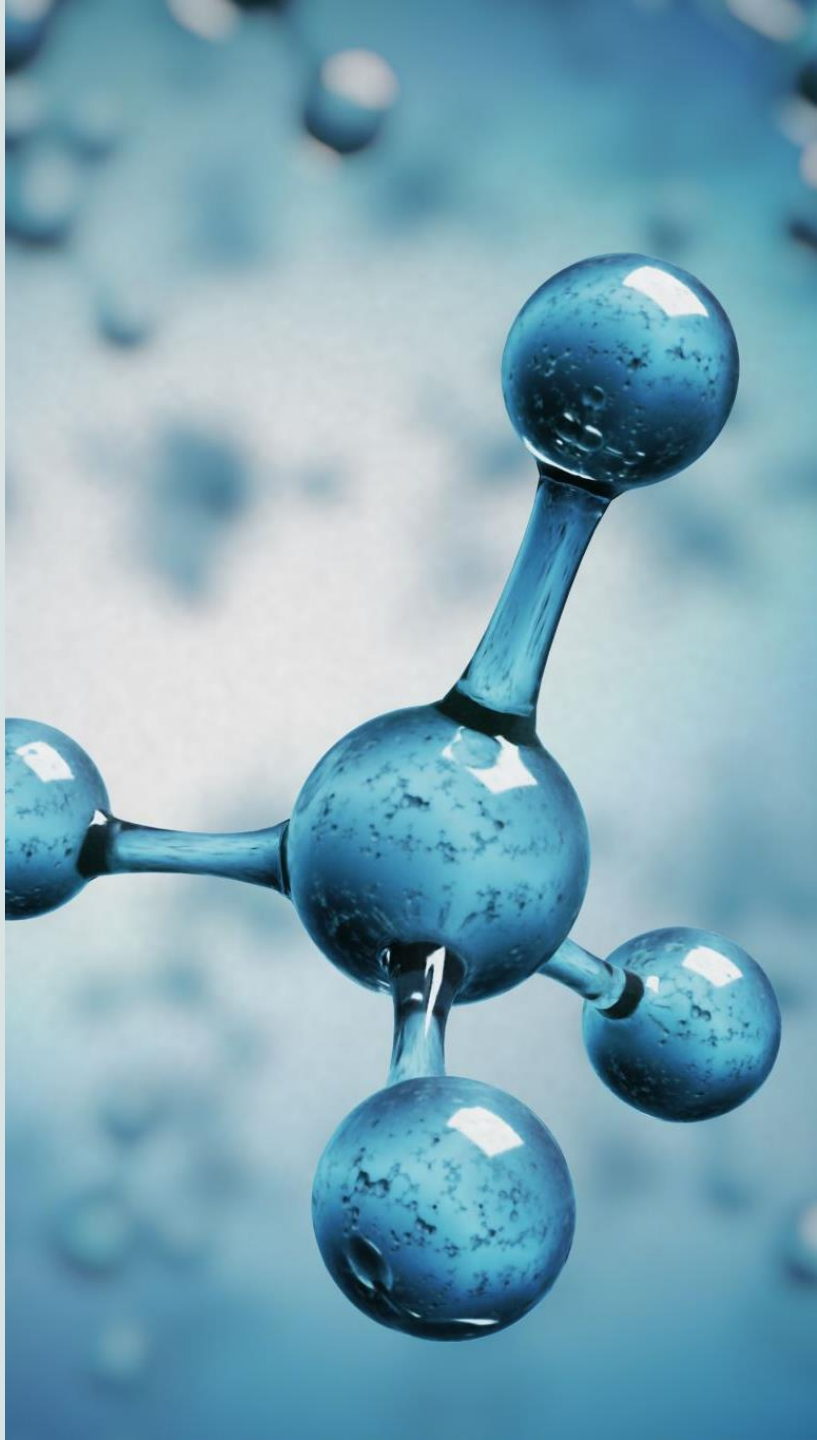
Cells can convert glucose into ATP—a substance with readily available energy



And this process called The Cellular Respiratory

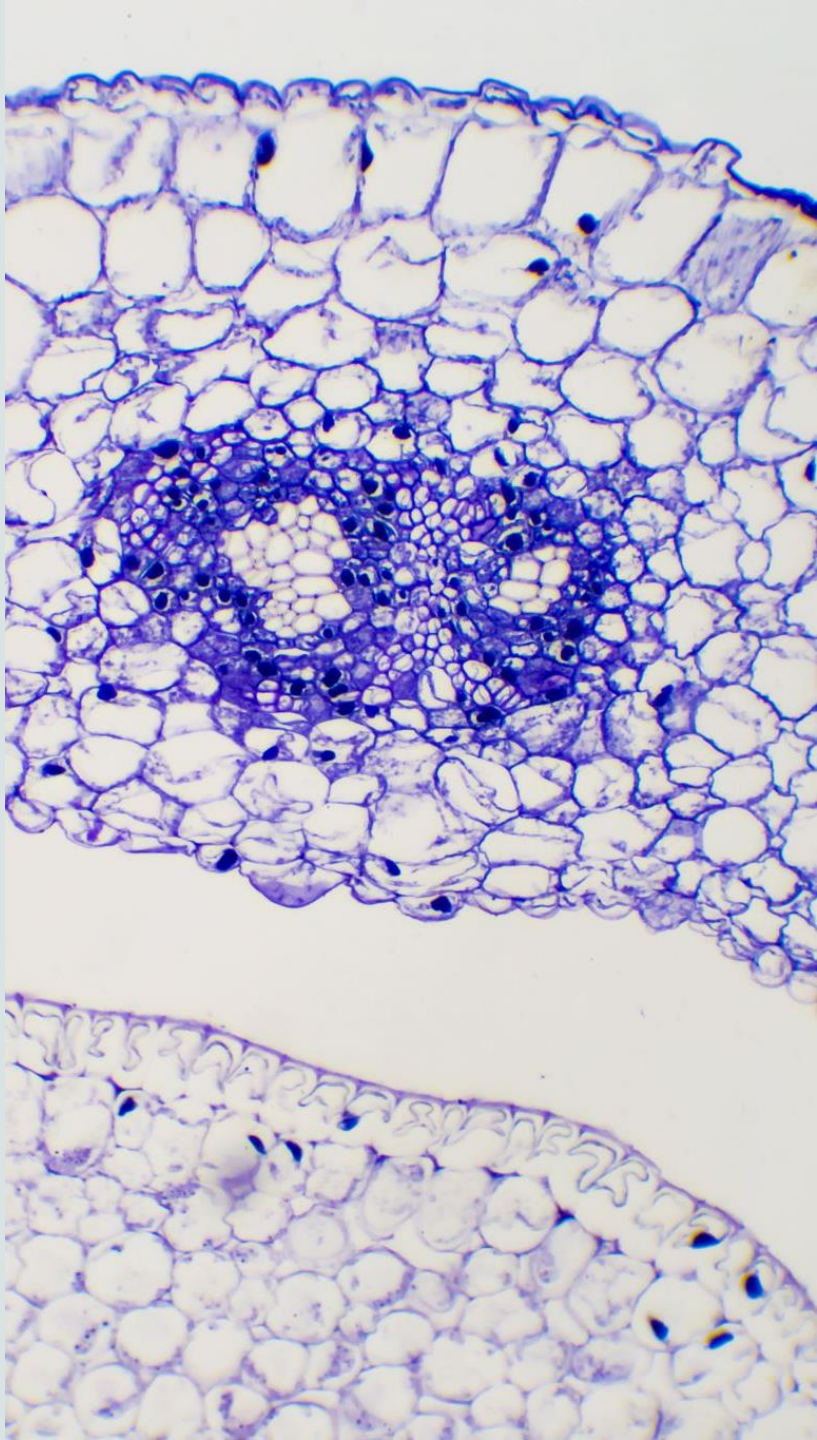
1.2 | Basic Properties of Cells
Cells Carry Out a Variety of Chemical Reactions

- Cells function like small chemical plants because they carry out several reactions (A bacterial cell is capable of hundreds of different chemical transformations) .
- The living things have **Enzymes** that facilitate the chemical reactions and make them take place in the ordinary conditions .
- The summation total of the chemical reactions in a cell represents that **Cell's Metabolism**.



1.2 | Basic Properties of Cells
Cells Engage in Mechanical Activities

- The three types of cellular work : * transportation * dynamical * physical
- Cells are very active, they can: transport materials, assemble and disassemble structures, and sometimes move itself from one site to another.
- The cytoskeleton inside the cells are dynamic , they are always been broken and reformed to perform a specific function .
- Activities are based on dynamic, mechanical changes within cells, many of which are initiated by changes in the shape of motor proteins. Also motor protein has its own internal chemical changes .
- Motor proteins are just one of many types of molecular machines used for mechanical activities.



1.2 | Basic Properties of Cells
Cells Are Able to Respond to Stimuli

- A single-celled protest can move away from an object in its path or toward nutrients.
- Cells in plants or animals are covered with receptors that interact with substances in the environment.
- Hormones, growth factors, extracellular materials, and substances on the surfaces of other cells can interact with these receptors causing a chemical changes or changing the gene expression .
- Cells may respond to stimuli by altering their metabolism, moving from one place to another, or even committing suicide.
- قد تستجيب الخلايا للمنبهات عن طريق تغيير عمليات التمثيل الغذائي ، والانتقال من مكان إلى آخر ، أو حتى الانتحار

1.2 | Basic Properties of Cells

Cells Are Capable of Self-Regulation

Cells are robust and are protected from dangerous fluctuations in composition and behavior.

الخلايا قوية ومحمية من التقلبات الخطيرة في التركيب والسلوك

Feedback circuits serve to return the cell to the appropriate state (cells protect themselves from consuming energy or materials or the increasing in them by **Allosteric Inhabitation**).

Maintaining a complex, ordered state requires constant regulation so feedback is important to keep the cell works.

1.3 | Two Fundamentally Different Classes of Cells

- Two basic classes of cells, prokaryotic and eukaryotic, are distinguished by their size and the types of organelles they contain.
- Many basic differences as well as many similarities between the two types.
- They share some properties :
- 1.cutosol 2.chromosomes
- 3.the presence of DNA (they are different in the location , shape and slight difference in composition)
- 4.plasma membrane in structure
- 5.The presence of Ribosomes (some antibiotics kills the bacterial ribosomes but can't affect the human one .

- Because of their common ancestry (origin), both types of cells share an identical genetic language , a common set of metabolic pathways, and many common structural features.
- Both types of cells are bounded by plasma membranes of similar construction that serve as a selectively permeable barrier (some materials con pas more easily than others)
- Both types of cells may be surrounded by a rigid cell wall that protects the cell the animal cells aren't surrounded by it .
- Eukaryotic cells are much more complex, both structurally and functionally, than prokaryotic cells.

PROKARYOTES ARE ALL BACTERIA, WHICH ARE CREATED BEFORE ALMOST 3.7 BILLION YEARS AGO.

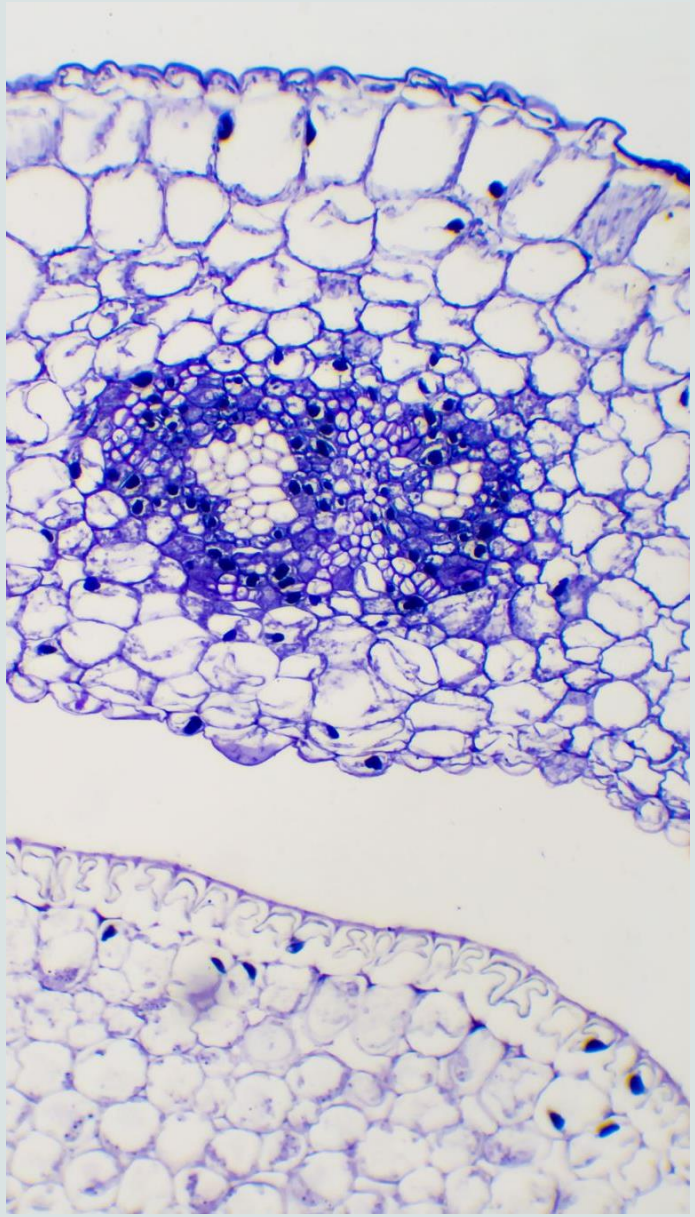
EUKARYOTES INCLUDE PROTISTS, ANIMALS, PLANTS AND FUNGI.

COMPLEX MULTICELLULAR ANIMALS APPEAR RATHER SUDDENLY IN THE FOSSIL RECORD APPROXIMATELY 600 MILLION YEARS AGO.

تظهر الحيوانات متعددة الخلايا المعقدة فجأة في سجل الحفريات منذ حوالي 600 مليون سنة

1.3 | Two Fundamentally Different Classes of Cells

- **Complexity**: Prokaryotes are relatively simple; eukaryotes are more complex in structure and function.
- **Cytoplasm**: Eukaryotes have membrane-bound organelles and complex cytoskeletal proteins. Both have ribosomes but they differ in size as we mentioned previously .
- **Cellular reproduction**: Eukaryotes divide by mitosis; prokaryotes divide by simple fission.
- **Locomotion**: Eukaryotes use both cytoplasmic movement, and cilia and flagella; prokaryotes have flagella, but they differ in both form and mechanism.



Genetic material:

Packaging: Prokaryotes have a nucleoid region whereas eukaryotes have a membrane-bound nucleus.

Amount: Eukaryotes have much more genetic material than prokaryotes.

Form: Eukaryotes have many chromosomes made of both DNA and protein whereas prokaryotes have a single, circular DNA.

A Comparison of Prokaryotic and eukaryotic Cells

- **Features held in common by the two types of cells:**
- **o Plasma membrane of similar construction**
- **o Genetic information encoded in DNA using identical genetic code**
- **o Similar mechanisms for transcription and translation of genetic information, including similar ribosomes**
- **o Shared metabolic pathways (e.g., glycolysis and TCA cycle)**
- **o Similar apparatus for conservation of chemical energy as ATP (located in the plasma membrane of prokaryotes and the mitochondrial membrane of eukaryotes)**
- **o Similar mechanism of photosynthesis (between cyanobacteria and green plants)**
- **o Similar mechanism for synthesizing and inserting membrane proteins**
- **o Proteasomes (protein digesting structures) of similar construction (between archaebacteria and eukaryotes)**
- **o Cytoskeletal filaments built of proteins similar to actin and tubulin**

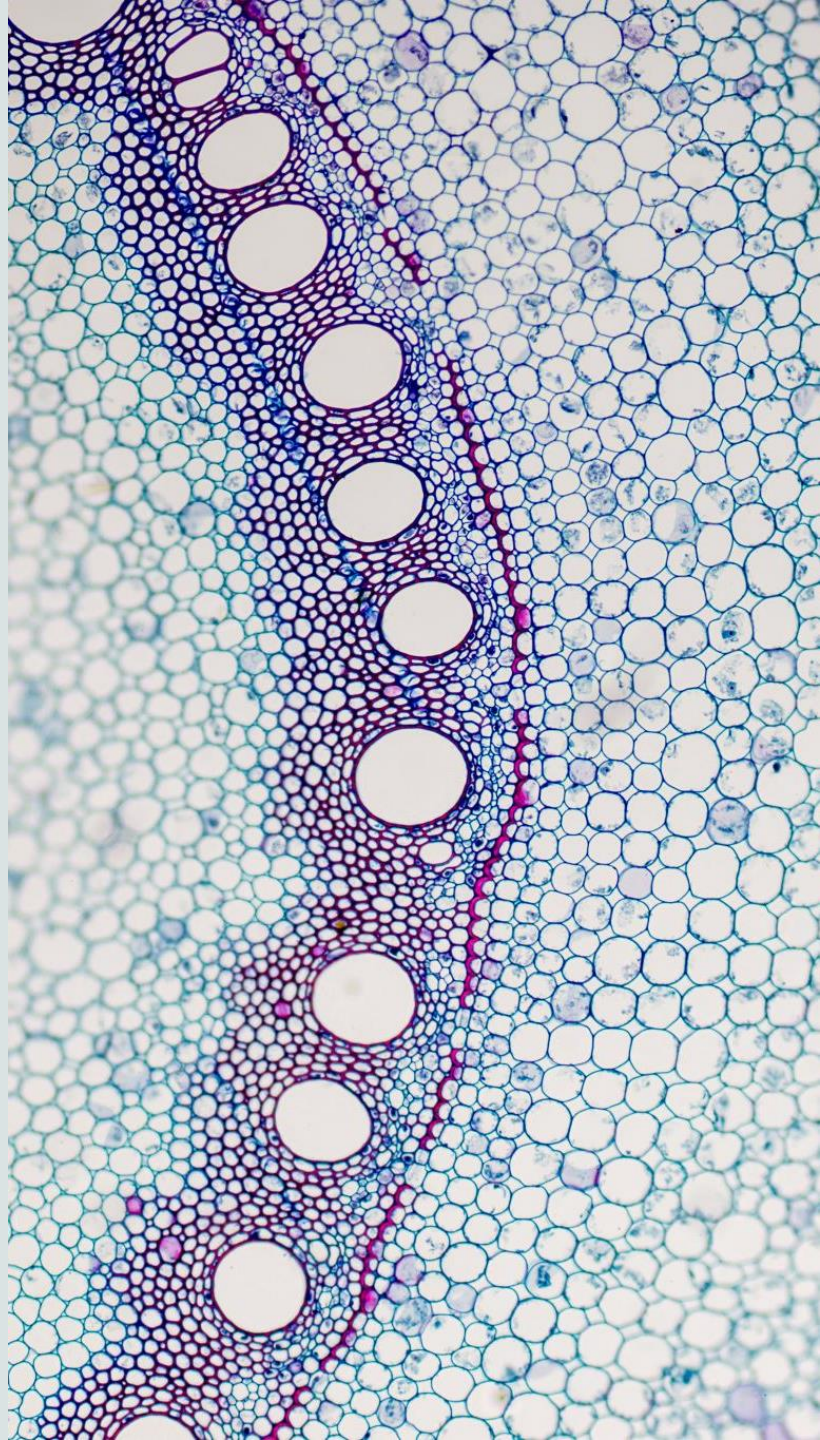
Features of eukaryotic cells not found in prokaryotes:

- **o Division of cells into nucleus and cytoplasm, separated by a nuclear envelope containing complex pore structures**
- **o Complex chromosomes composed of DNA and associated proteins that are capable of compacting into mitotic structures**
- **o Complex membranous cytoplasmic organelles (includes endoplasmic reticulum, Golgi complex, lysosomes, endosomes, peroxisomes, and glyoxisomes)**
- **o Specialized cytoplasmic organelles for aerobic respiration (mitochondria) and photosynthesis (chloroplasts)**
- **o Complex cytoskeletal system (including actinfilaments, intermediate filaments, and microtubules) and associated motor proteins**
- **o Complex flagella and cilia**
- **o Ability to ingest particulate material by enclosure within plasma membrane vesicles (phagocytosis)**
- **o Cellulose-containing cell walls (in plants)**
- **o Cell division using a microtubule-containing mitotic spindle that separates chromosomes**
- **o Presence of two copies of genes per cell (diploidy), one from each parent**
- **o Presence of three different RNA synthesizing enzymes (RNA polymerases)**
- **o Sexual reproduction requiring meiosis and fertilization**

- **Eukaryotic cells possess a nucleus: a region bounded by a membranous structure called the nuclear envelope.**
- **The cytoplasm of a eukaryotic cell is filled with a great diversity of structures.**
- **The cytoplasmic membranes form a system of interconnecting channels and vesicles that function in the transport of substances from one part of a cell to another.**

The cytoplasm

- The cytoplasm of a eukaryotic cell is extremely crowded, leaving very little space for the soluble phase of the cytoplasm, the cytosol.
- The cytoplasm near the cell membrane is a region where membrane-bound organelles tend to be absent.
- The cytoskeleton and other large macromolecular complexes, mostly ribosomes, are found throughout the cytoplasm.



The mitosis

Eukaryotic cells divide by a complex process of mitosis.

Duplicated chromosomes condense into compact structures that are segregated by an elaborate microtubule-containing apparatus.

This apparatus, the mitotic spindle, allows each daughter cell to receive an equivalent array of genetic material.

The simple fission

- Prokaryotes are mostly nonsexual organisms.
- They contain one copy of their single chromosome and have no processes comparable to meiosis, gamete formation, or true fertilization.
- Some are capable of conjugation, in which a piece of DNA is passed to another cell.
- Prokaryotes are more adept at picking up and incorporating foreign DNA from their environment, which has had considerable impact on microbial evolution

The locomotion

- Locomotion in prokaryotes is relatively simple.
- Can be accomplished by a thin protein filament, called a flagellum, which protrudes from the cell and rotates.
- The rotations exert pressure against the surrounding fluid, propelling the cell through the medium.
- Certain eukaryotic cells, including many protists and sperm cells, also possess flagella (9+2).
- Eukaryotic versions are much more complex than the simple protein filaments of bacteria, and they generate movement by a different mechanism.

1.4 | Types of Prokaryotic Cells
Domain Archaea and Domain Bacteria

- **The best known Archaea are species that live in extremely inhospitable environments, often referred to as —extremophiles . Methanogens: Convert CO_2 and H_2 gases into methane**
- **Halophiles: Live in extremely salty environments, like the Dead Sea or deep sea brine pools with salinity equivalent to 5M $MgCl_2$.**
- **Acidophiles: Acid-loving prokaryotes that thrive at a pH as low as 0.**
- **Thermophiles: Live at very high temperatures.**
- **Hyperthermophiles: Live in the hydrothermal vents of the ocean floor up to a temperature of 121oC, the temperature used to sterilize surgical instruments in an autoclave.**

- Domain Bacteria includes the smallest known cells, the mycoplasma, which lack a cell wall , it doesn't affect other cells strongly but it competes them in nutrients and this causes decreasing in division .
- Bacteria are present in every conceivable habitat on Earth, even found in rock layers kilometers beneath the Earth’s surface.
- Cyanobacteria contain arrays of cytoplasmic membranes that serve as sites of photosynthesis.
- Cyanobacteria gave rise to green plants and an oxygen-rich atmosphere, and some are capable of nitrogen fixation.

Prokaryotic Diversity

- **Roughly 6000 species of prokaryotes have been identified, less than one-tenth of 1 percent of the millions of prokaryotic species thought to exist.**
- **DNA sequencing is so rapid and cost-efficient that virtually all of the genes present in the microbes of a given habitat can be sequenced, generating a collective genome, or metagenome.**
- **These same molecular strategies are being used to explore the collection of microbes living on us, known as the human microbiome.**
- **Functions of proteins encoded by these microbial genomes include the synthesis of vitamins, the breakdown of complex plant sugars, and the prevention of growth of pathogenic organisms.**

The microbiomes

- **The types of bacteria that lives inside the healthy and non-healthy bodies are different .**
- **Inside the cow the bacteria breaks down the cellulose .**
- **There are microbiomes live over the human skin and they are extremely important**

1.5 | Types of Eukaryotic Cells

- The most complex eukaryotic cells may not be found inside of plants or animals, but rather among the single-celled protists.

في الأوليات وحدية الخلايا مش داخل النبات او الحيوان يعني أكثر الخلايا حقية النوى تعقيدا ممكن نلاقيها

The machinery needed for sensing the environment, trapping food, expelling excess fluid, and evading predators is found in a single cell.

تم العثور على الوسائل اللازمة لاستشعار البيئة ، وحبس الطعام ، وطرد السوائل الزائدة ، وتجنب الحيوانات المفترسة في الخلية المفردة مثل الأوليات.

Vorticella have a contractile ribbon in the stalk and a large macronucleus that contains multiple copies of its

Genes

Vorticella : a sedentary, single-celled aquatic animal with a contractile stalk and a bell-shaped body bearing a ring of cilia.

يحتوي هذا الكائن وحيد الخلية على شريط مقلص في الساق ونواة كبيرة تحتوي على نسخ متعددة منه

الجينات

1.5 | Types of Eukaryotic Cells Cell Differentiation

Cell Differentiation

- Multicellular eukaryotes have different cell types for different functions.

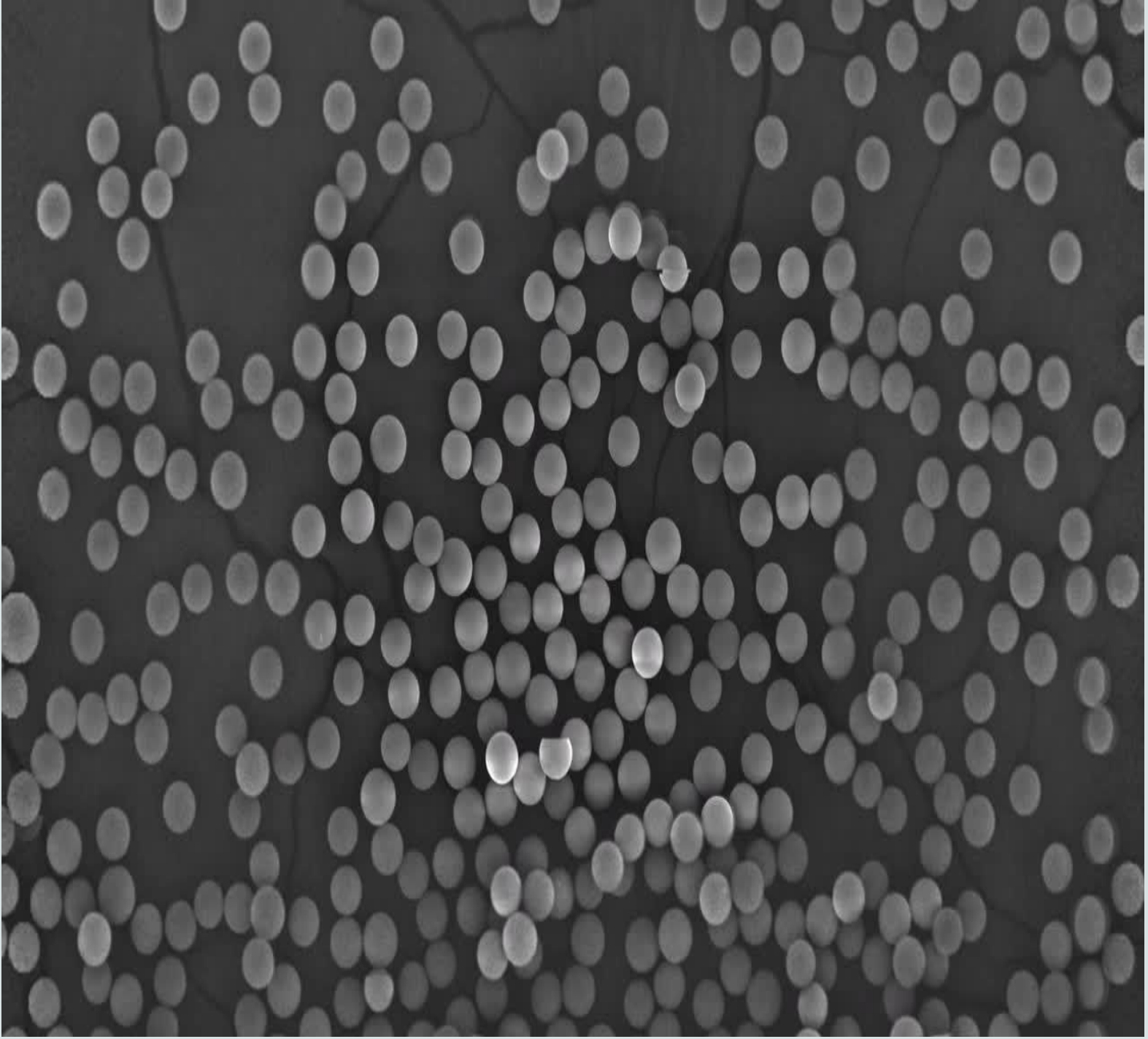
- Cell differentiation occurs during embryonic development in multicellular organisms.

- The numbers and arrangements of organelles relate to the function and activity of the cell.

- Despite differentiation, cells have many features in common most being composed of the same organelles.

TRANSLATION

- حقيقيات النوى متعددة الخلايا لها أنواع خلايا مختلفة لوظائف مختلفة
- يحدث تمايز الخلايا أثناء التطور الجنيني في الكائنات متعددة الخلايا
- ترتبط أعداد وترتيبات العضيات بوظيفة الخلية ونشاطها
- على الرغم من التمايز ، فإن الخلايا لها العديد من السمات المشتركة ، ومعظمها تتكون من نفس العضيات



THE SIZES OF CELLS AND THEIR COMPONENTS

- Cells are commonly measured in units of micrometers (1 μm = 10–6 meter) and nanometers (1 nm = 10–9 meter).

The cell size is limited:

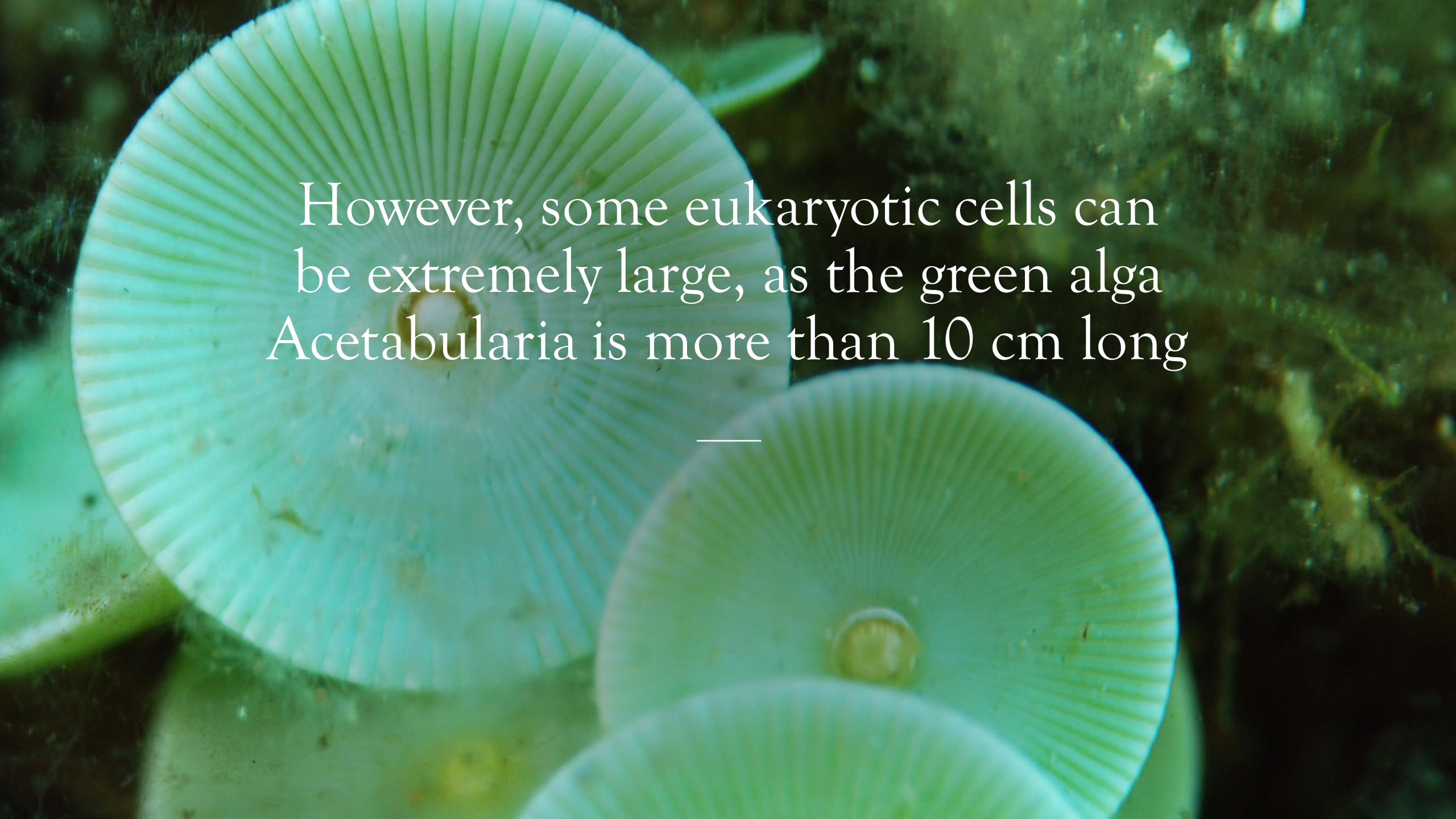
- 1) By the volume of cytoplasm that can be supported by the genes in the nucleus.
- حسب حجم السيتوبلازم الذي يمكن أن تدعمه الجينات في النواة

2) By the volume of cytoplasm that can be supported by exchange of nutrients.

من خلال حجم السيتوبلازم الذي يمكن دعمه عن
طريق تبادل العناصر الغذائية

3) By the distance over which substances can efficiently travel through the cytoplasm via diffusion.

بالمسافة التي يمكن للمواد أن تنتقل خلالها بكفاءة عبر السيتوبلازم عن طريق الانتشار



However, some eukaryotic cells can be extremely large, as the green alga Acetabularia is more than 10 cm long

Synthetic Biology is a field oriented to create a living cell in the laboratory.

more modest goal is to develop novel life forms, beginning with existing organisms.

الهدف الأكثر تواضعًا هو تطوير أشكال حياة جديدة ، بدءًا من الكائنات الحية الموجودة


Possible applications to
medicine, industry, or
the environment.

Prospect is good after replacing the genome of one bacterium with that of a closely related species

الاحتمال جيد بعد استبدال جينوم بكتيريا واحدة بجينوم من نوع وثيق الصلة

YOU ARE SOMEONE WHO WILL SAVE LIVES IN THE FUTURE
BE PROUD OF YOURSELF AND ENJOY THESE MOMENTS

We never stop making ourselves
be yourself when this world is trying to make you another one

Best wishes to all doctors

Salsabeel Aljawabrah