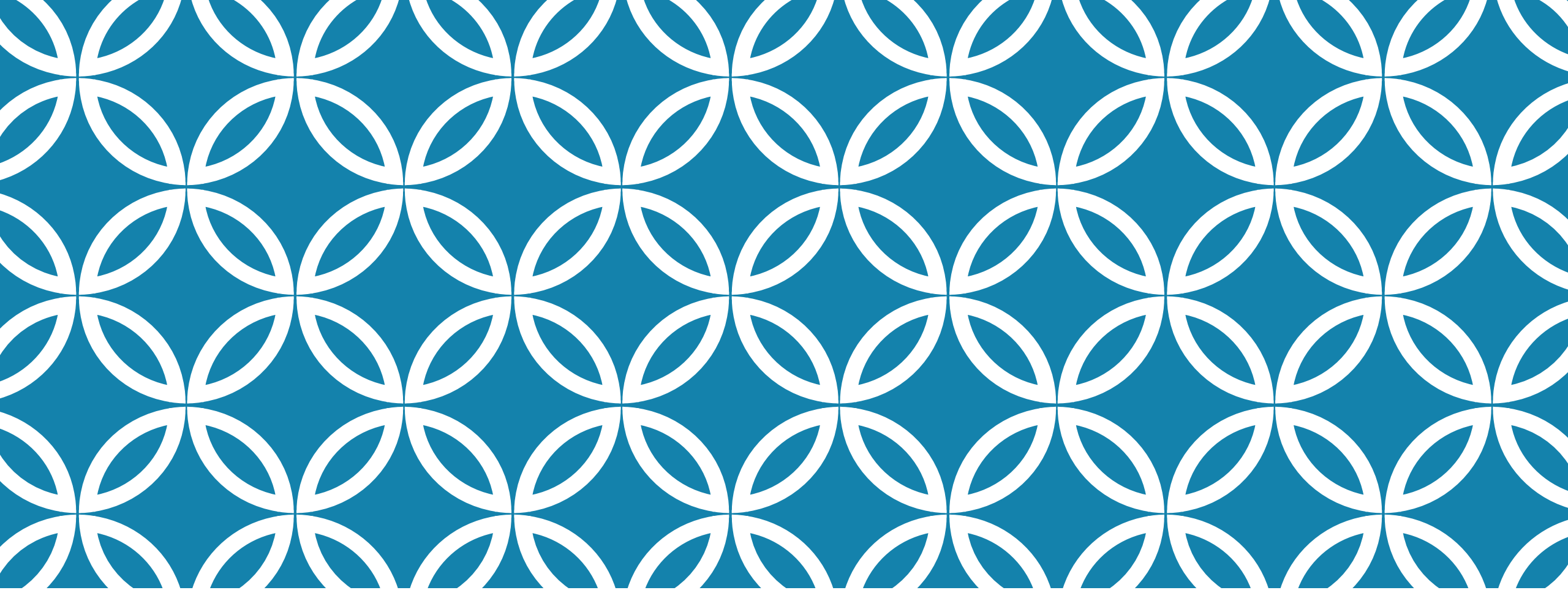


CHAPTER 4.1

Cell Theory

„SPONTANEOUS GENERATION“

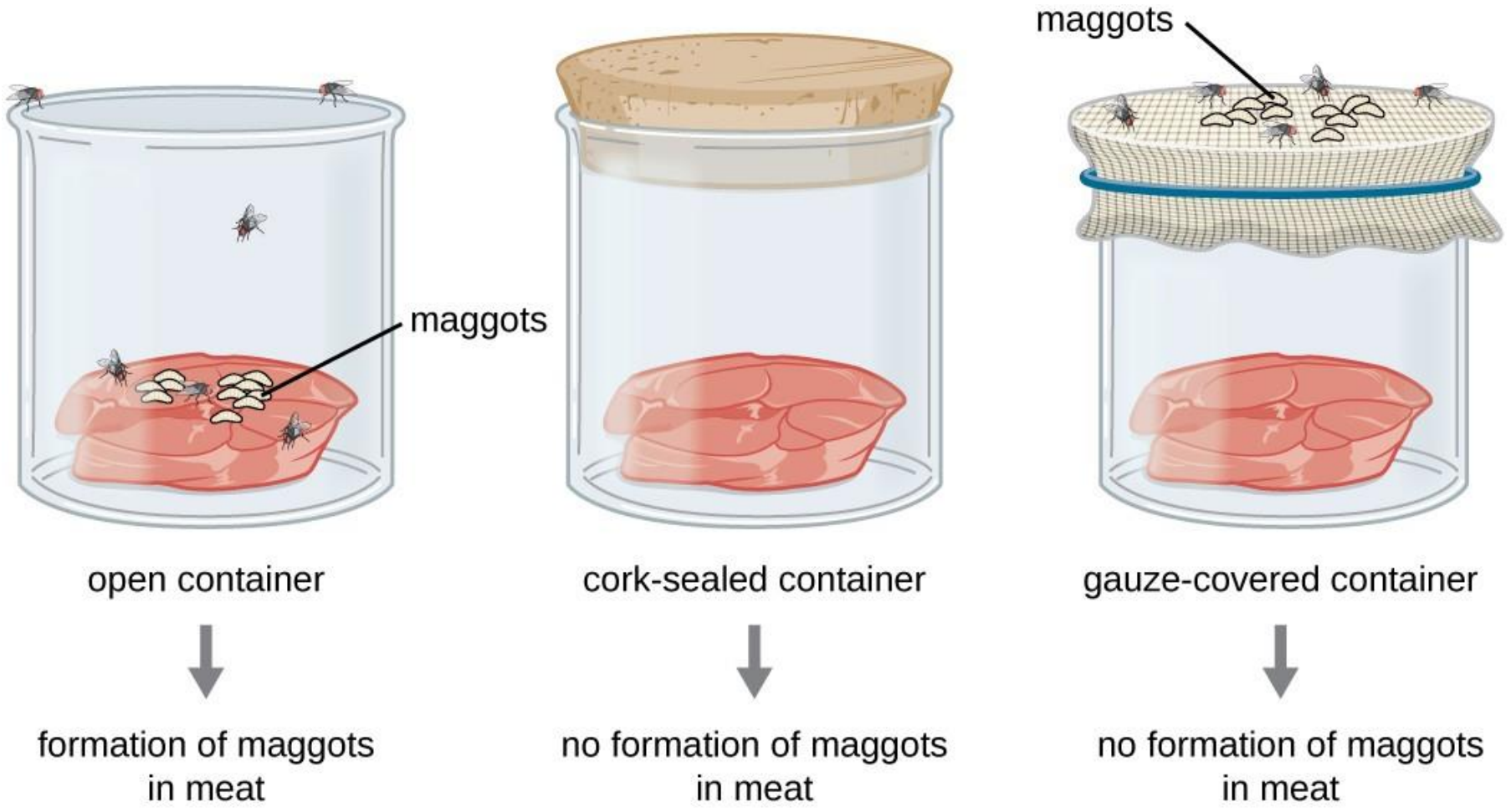
In the Middle ages, scientists thought that life could come from non-living matter.

JAN BAPTISTA VAN HELMONT‘S RECIPE FOR MICE

„Place a dirty shirt or some rags in an open pot or barrel containing a few grains of wheat or some wheat bran, and in 21 days mice will appear. There will be adult males and females present, and they will be capable of mating and reproducing more mice“

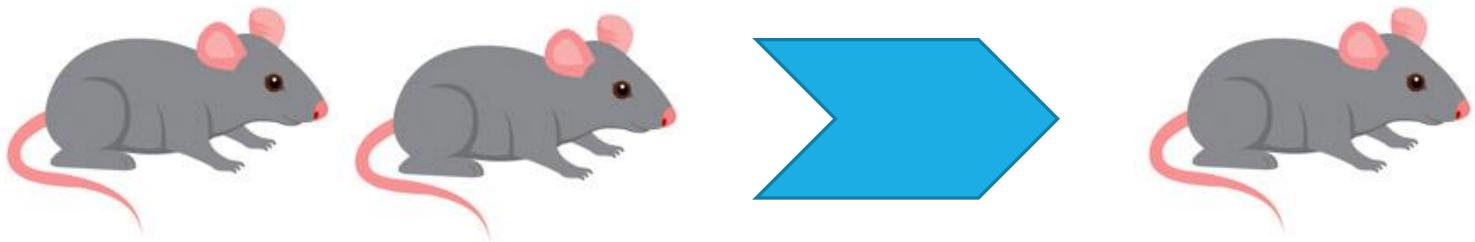
(17th century)

THE CELL THEORY



THE CELL THEORY

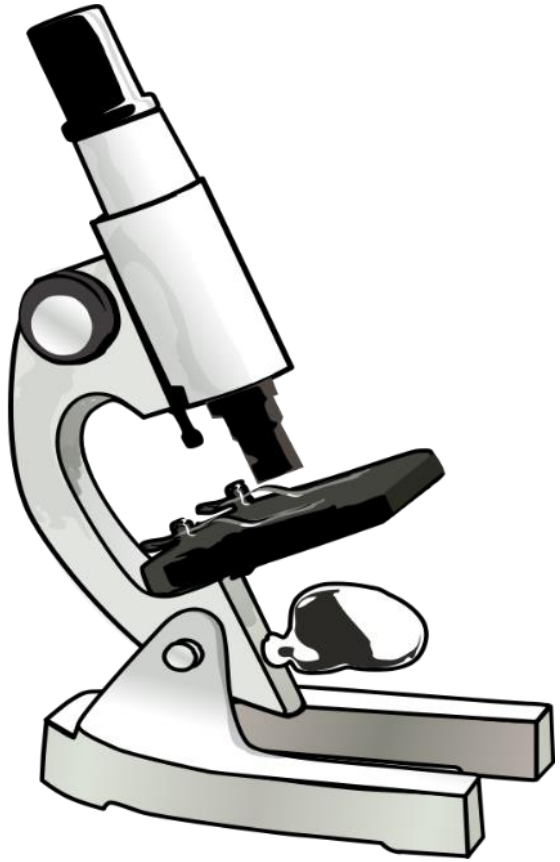
Scientists finally realized life only comes from other life



HISTORY OF THE CELL THEORY

https://www.youtube.com/watch?v=4OpBylwH9DU

MILESTONE IN CELLULAR BIOLOGY



FIRST VIEW OF CELLS

Robert Hooke (1665)

Cork cells (viewed under an early microscope)

It appeared, other organisms were also made of cells.

THE CELL THEORY

- All living things are composed of cells or cell products allthough the smallest organisms may consist of one cell only

- The cell is the smallest unit of life

- Cells only arise from pre-existing cells

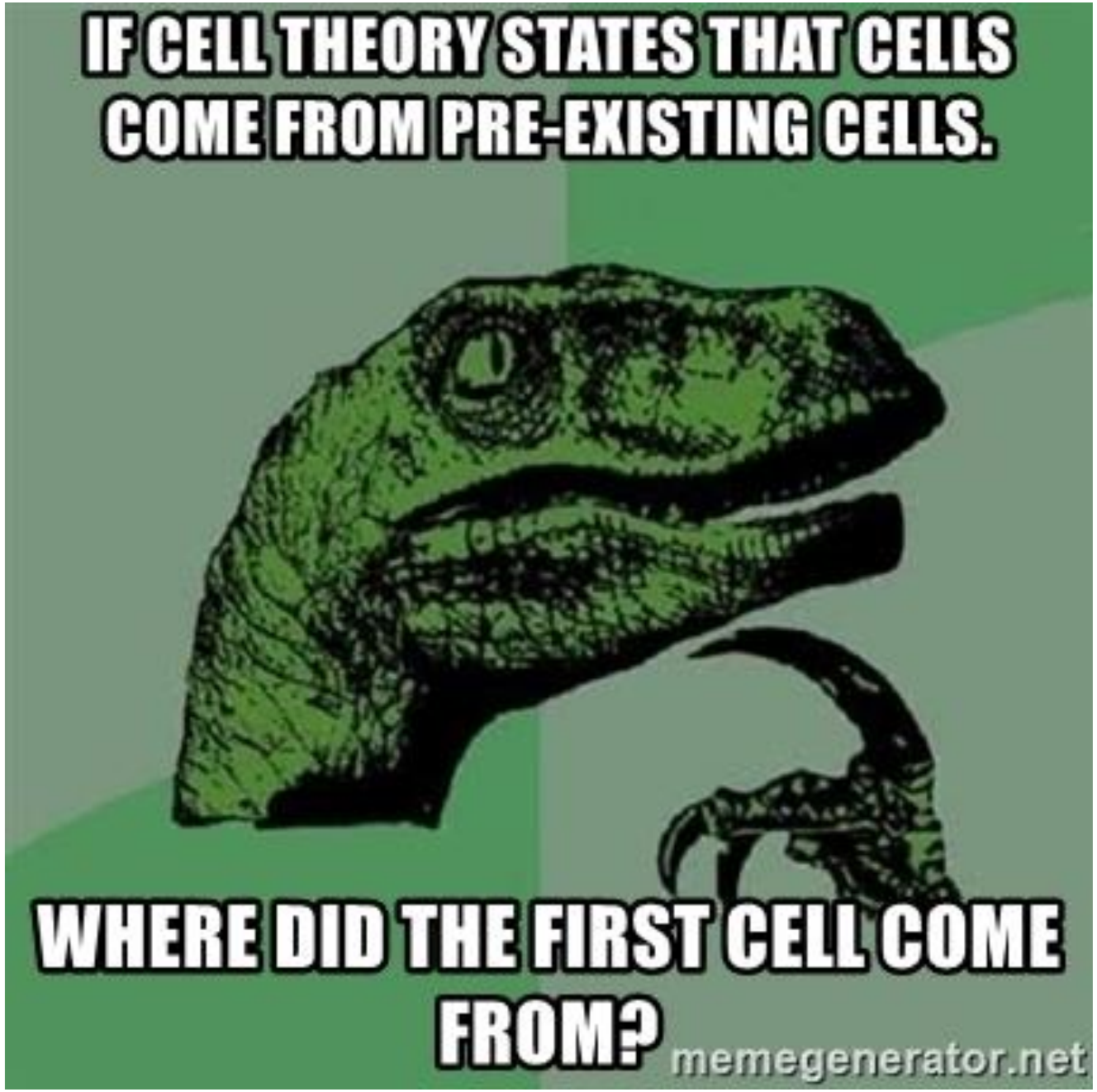
THE CELL THEORY

The cell is the smallest unit of life

→ specialized structures within cells (organelles) carry out different functions → ORGANELLES CANNOT SURVIVE ON THEIR OWN!!!

Cells only arise form pre-existing cells

- multiply through division
- all life evolved from simpler ancestors
- mitosis vs meiosis


IF CELL THEORY STATES THAT CELLS COME FROM PRE-EXISTING CELLS.
WHERE DID THE FIRST CELL COME FROM?
memegenerator.net

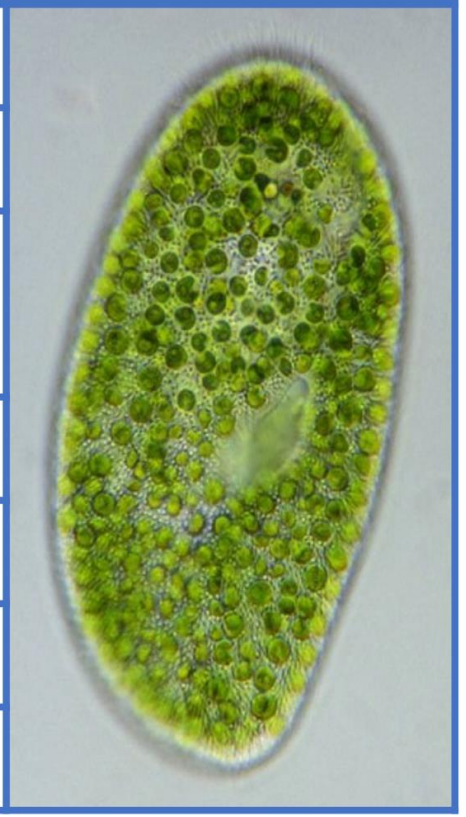
LIFE FUNCTION

All living things carry out 7 basic life functions:

- **M**etabolism *(undertakes essential chemical reactions)*
- **R**eproduction *(produces offspring – sexually or asexually)*
- **S**ensitivity *(responsive to internal and external stimuli)*
- **H**omeostasis *(maintains a stable internal environment)*
- **E**xcretion *(able to remove toxic waste products)*
- **N**utrition *(exchanges material with the environment)*
- **G**rowth / movement *(changes shape / size / position)*

Mnemonic: MR SHENG

LIFE FUNCTION EXAMPLES

Paramecium			Chlorella	
	Heterotrophic	**M**	Autotrophic	
	Asexual (mitosis)	**R**	Asexual (mitosis)	
	Chemotaxis (towards food)	**S**	Phototaxis (towards light)	
	Keeps equilibrium	**H**	Keeps equilibrium	
	Via anal pore	**E**	Via diffusion	
	Food vacuoles	**N**	Photosynthesis	
	Moves via cilia	**G**	Non-motile	

ARE VIRUSES ALIVE?

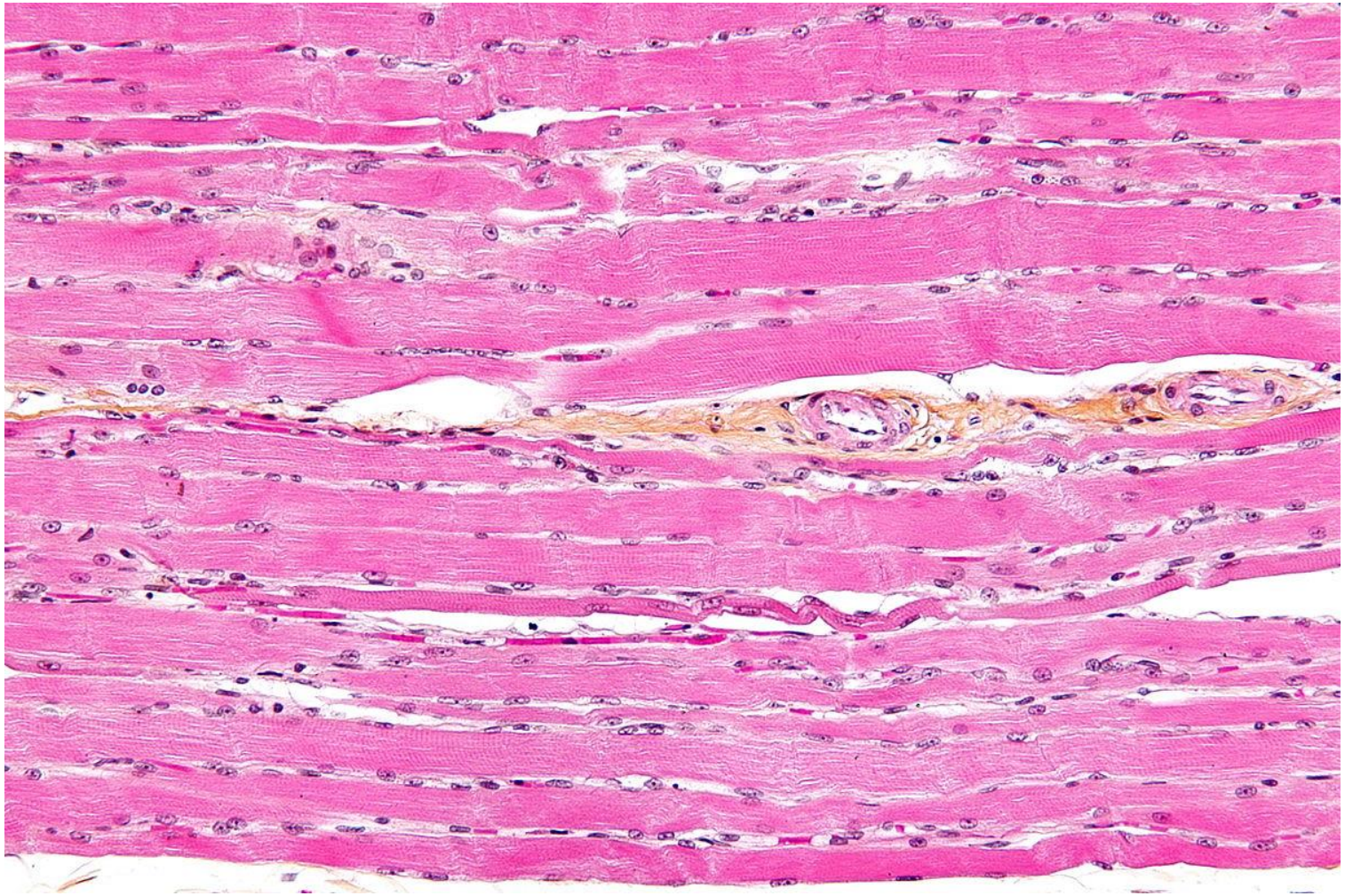
not cells

DNA or RNA wrapped up in protein coat

Few other living characteristics

Require a host to survive

QUESTIONING THE CELL THEORY:



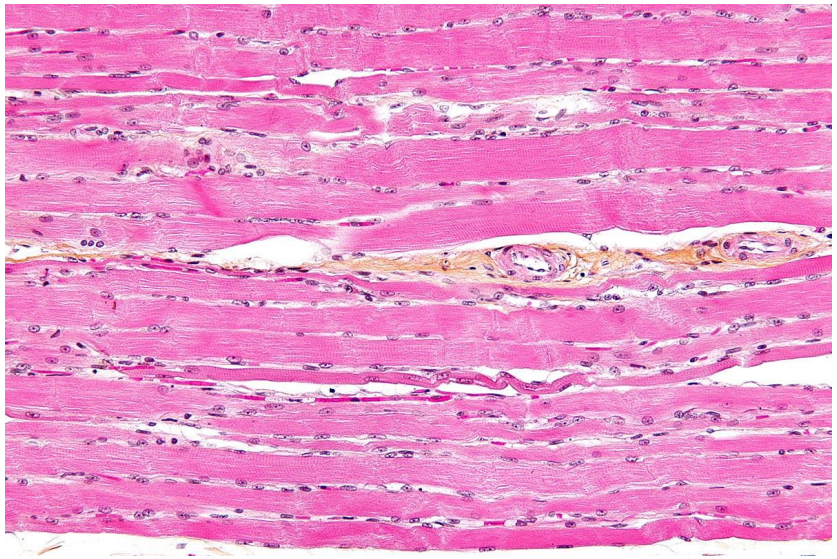
striated muscle tissue

QUESTIONING THE CELL THEORY

Muscle cells fuse to form fibres that may be very long (>300mm)

→ multiple nuclei despite being surrounded by a single, continuous plasma membrane

Challenges the idea that cells always function as autonomous units



QUESTIONING THE CELL THEORY

Aseptate fungal hyphae

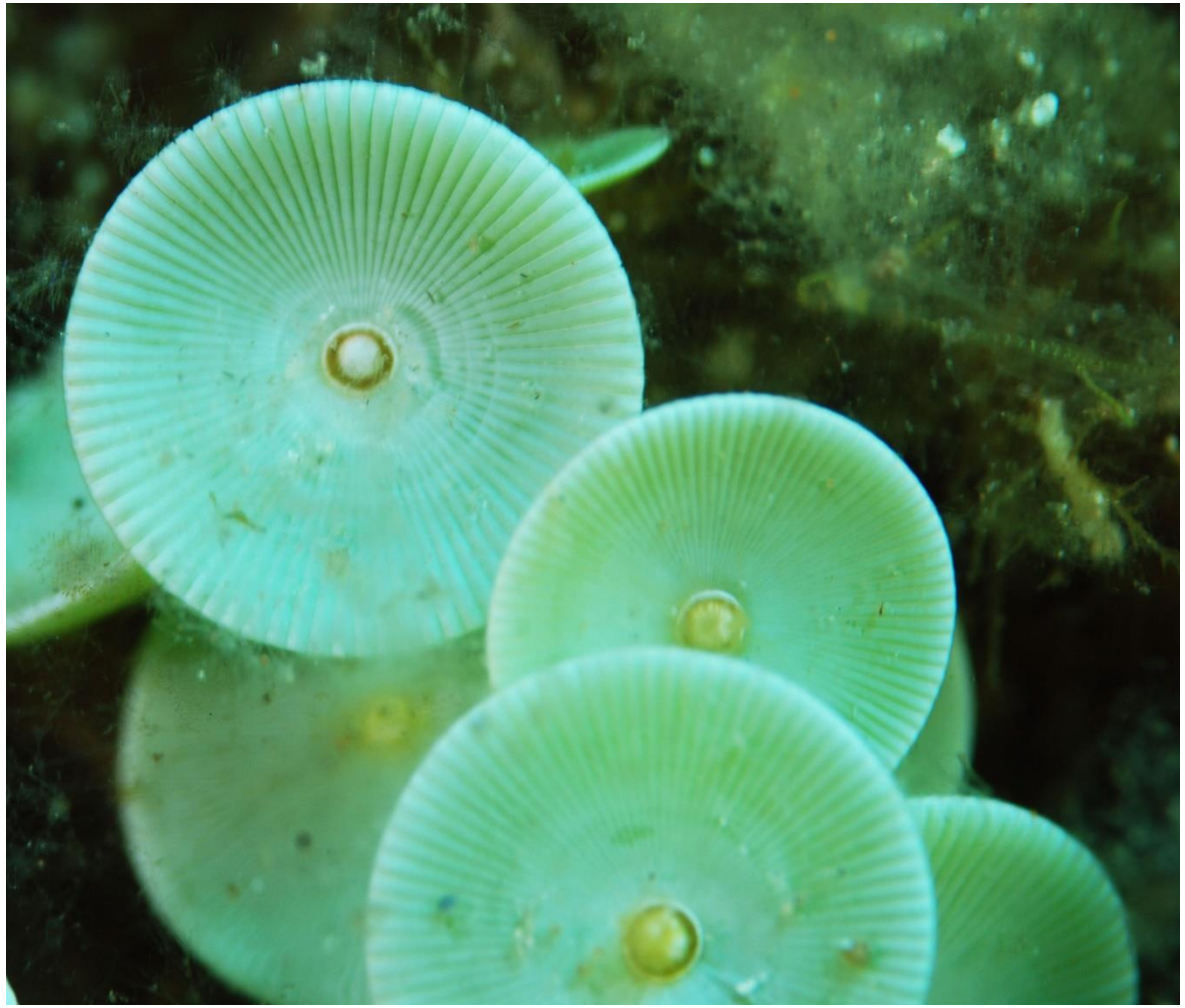
QUESTIONING THE CELL THEORY

Fungi may have filamentous structures called hyphae, which are separated into cells by internal walls called septa

Some fungi are not partitioned by septa → continuous cytoplasm along the length of the hyphae

Challenges the idea that living structures are composed of discrete cells

QUESTIONING THE CELL THEORY

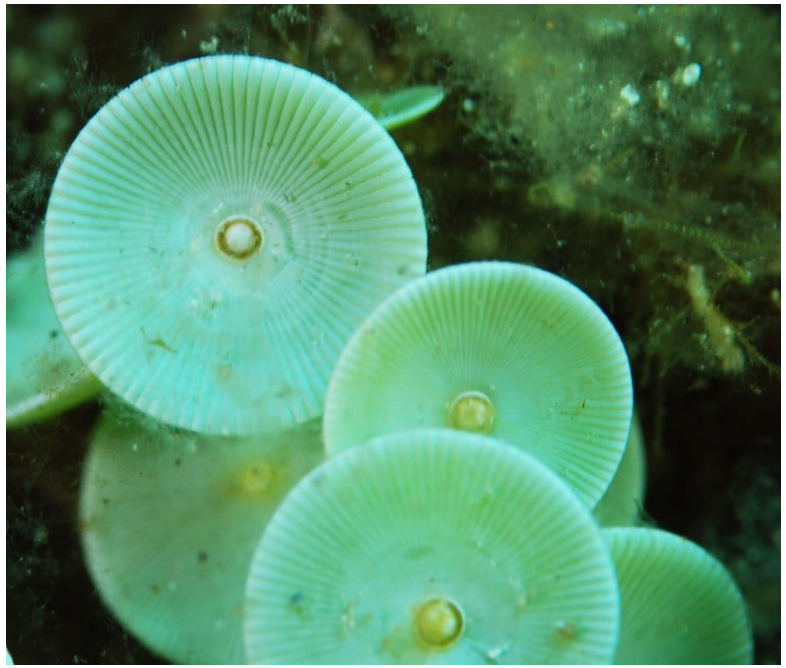


Giant algae

QUESTIONING THE CELL THEORY

Certain species of unicellular algae may grow to very large sizes (e.g. Acetabularia may exceed 7 cm in length)

Challenges the idea that larger organisms are always made of many microscopic cells



MAGNIFICATION

To calculate linear magnification of a drawing or image, use the following calculation:

- **MIA: M**agnification = **I**mage size ÷ **A**ctual size

To calculate the actual size of a drawing or image, use the following calculation:

- **AIM: A**ctual size = **I**mage size ÷ **M**agnification

REVISION: THE METRIC SYSTEM

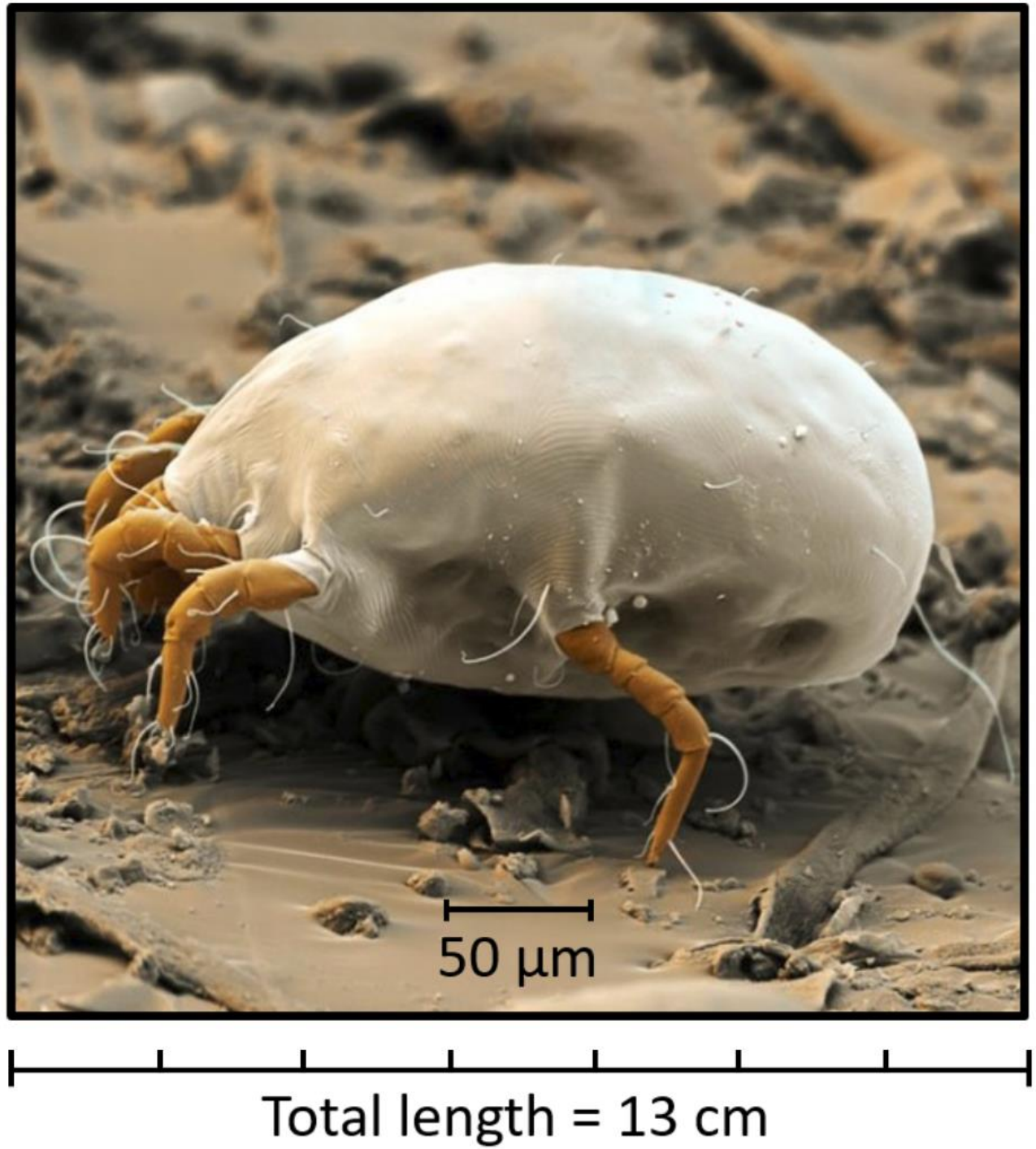
Unit	Prefix	Symbol
1	**metre**	**m**
10^{-3}	milli	mm
10^{-6}	micro	µm
10^{-9}	nano	nm
10^{-12}	pico	pm

÷ 1000

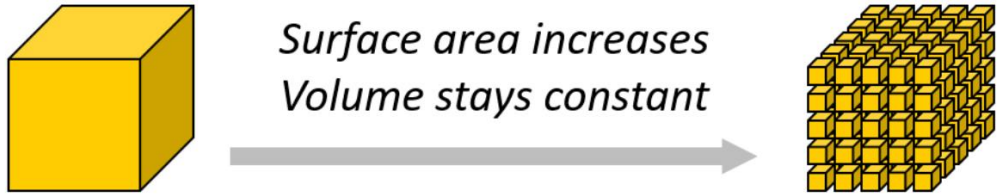
÷ 1000

÷ 1000

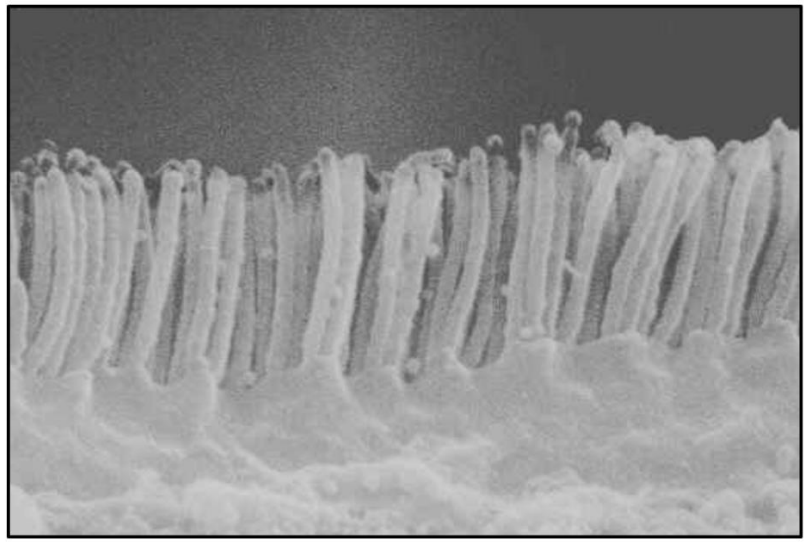
÷ 1000


50 µm
Total length = 13 cm

SURFACE AREA : VOLUME RATIO



150	**Total surface area** (height × width × sides × number of boxes)	750
125	**Total volume** (height × width × length × number of boxes)	125
1.2	**SA:Vol ratio** (surface area ÷ volume)	**6**

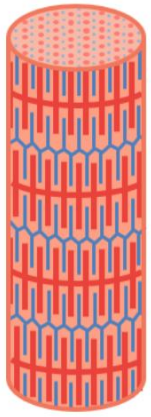


Cells / tissues may increase their surface area to optimise transfer

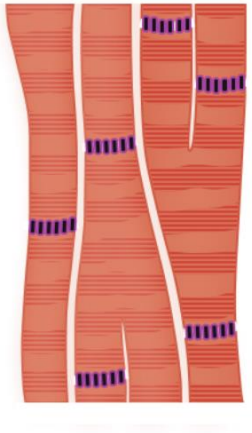
(**e.g.** *microvilli* = ↑ SA:Vol ratio)

MULTICELLULAR ORGANISMS

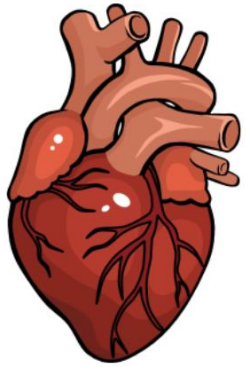
Cell
(muscle)



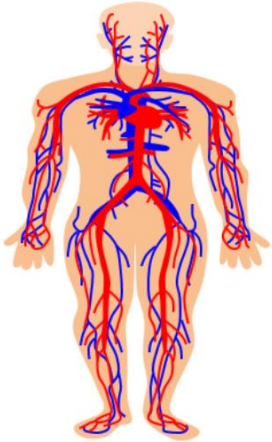
Tissue
cardiac



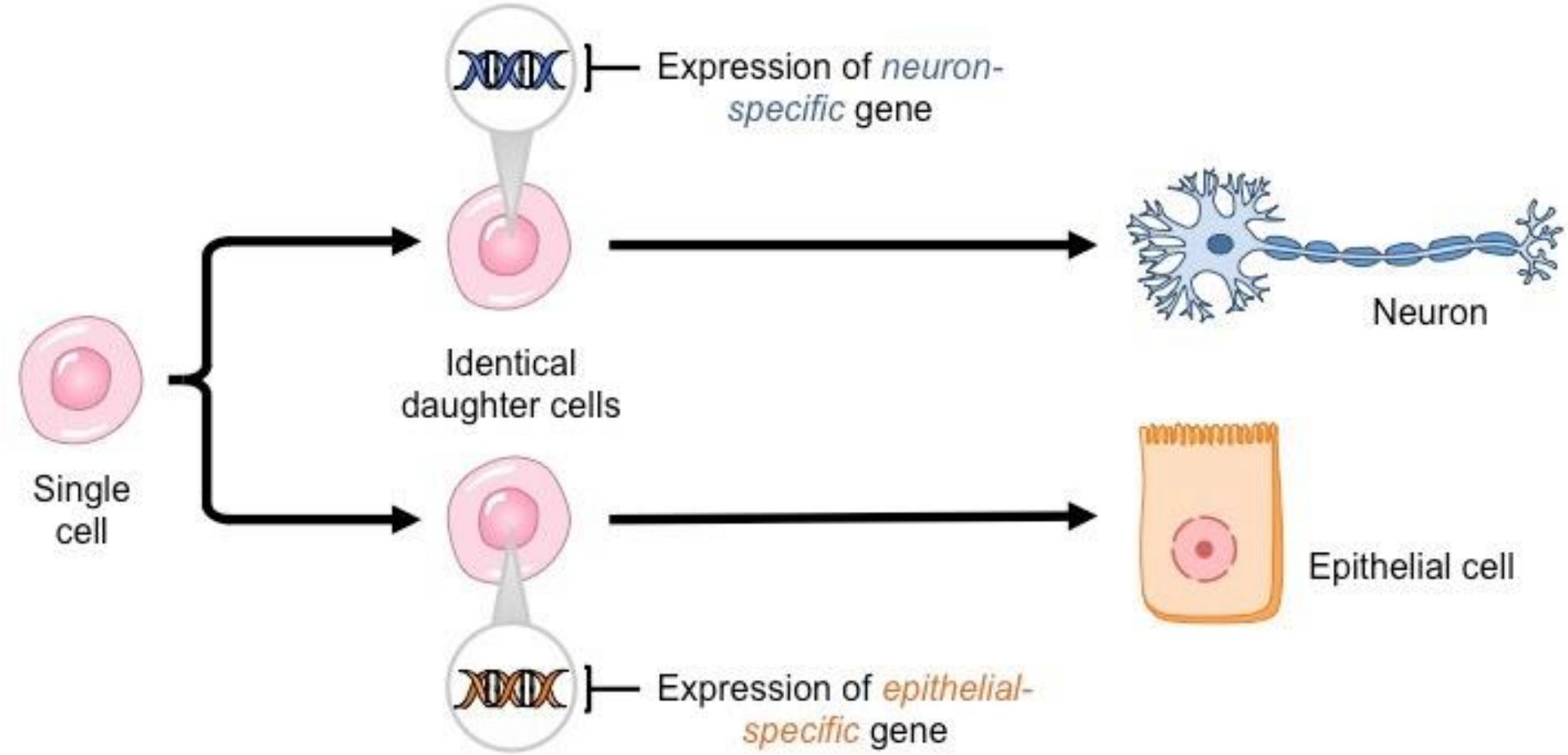
Organ
heart



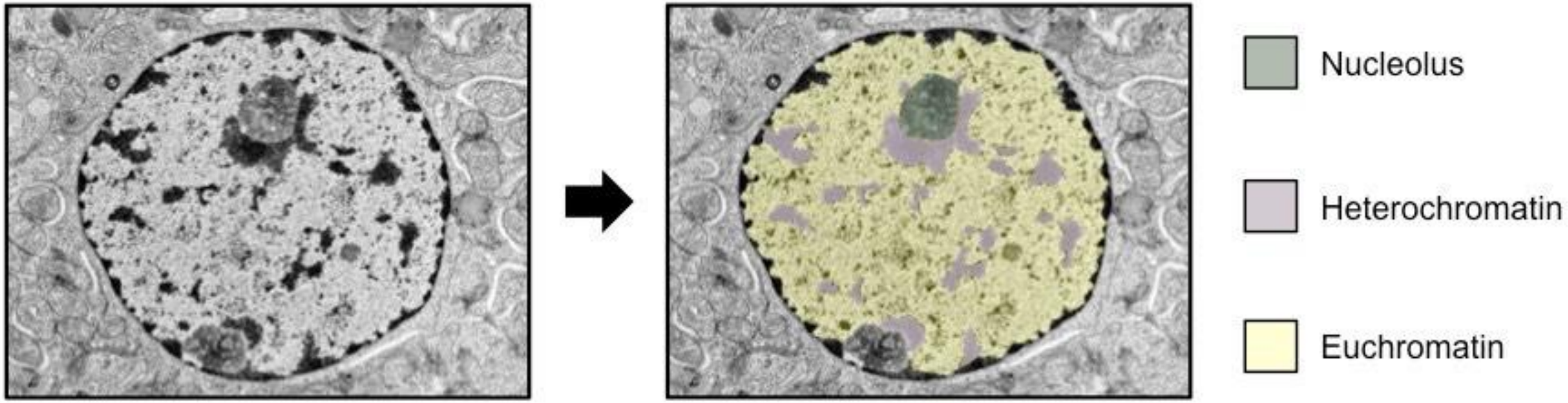
System
cardio vascular



CELL DIFFERENTIATION

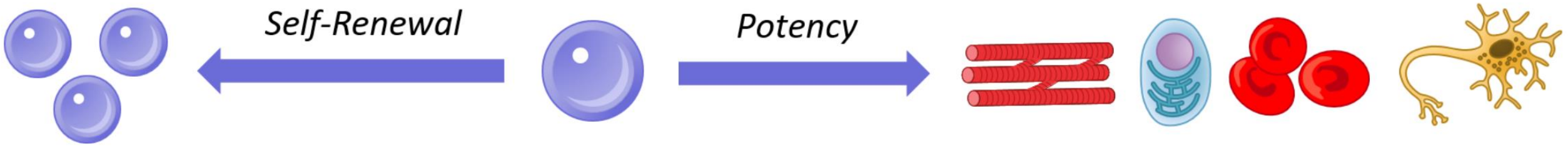


GENE PACKAGING



STEM CELLS

Stem cells are unspecialised cells that have two key qualities:



Self-renewal = can continually divide and replicate

Potency = they have the capacity to differentiate into specialized cells

STEM CELLS:

Totipotent – Can form any cell type, as well as extra-embryonic (placental) tissue

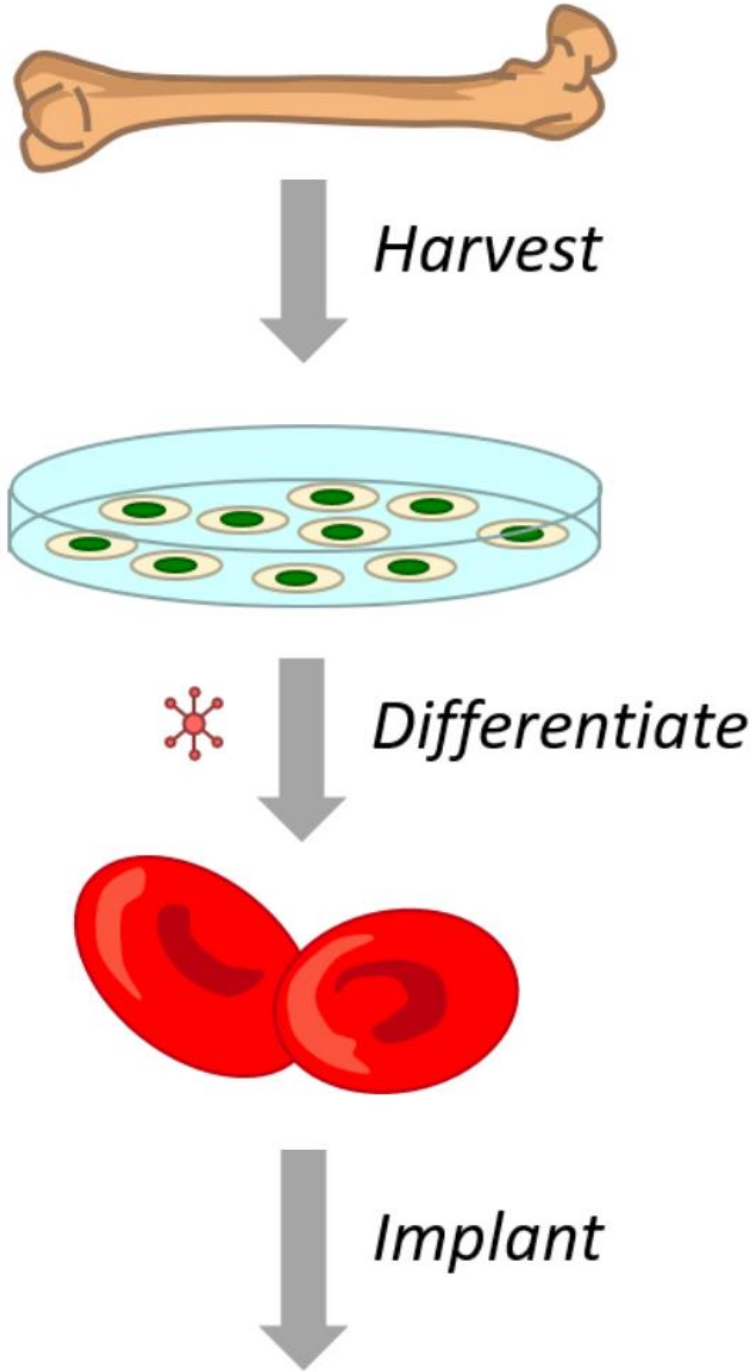
Pluripotent – Can form any cell type

Multipotent – Can differentiate into a number of closely related cell types

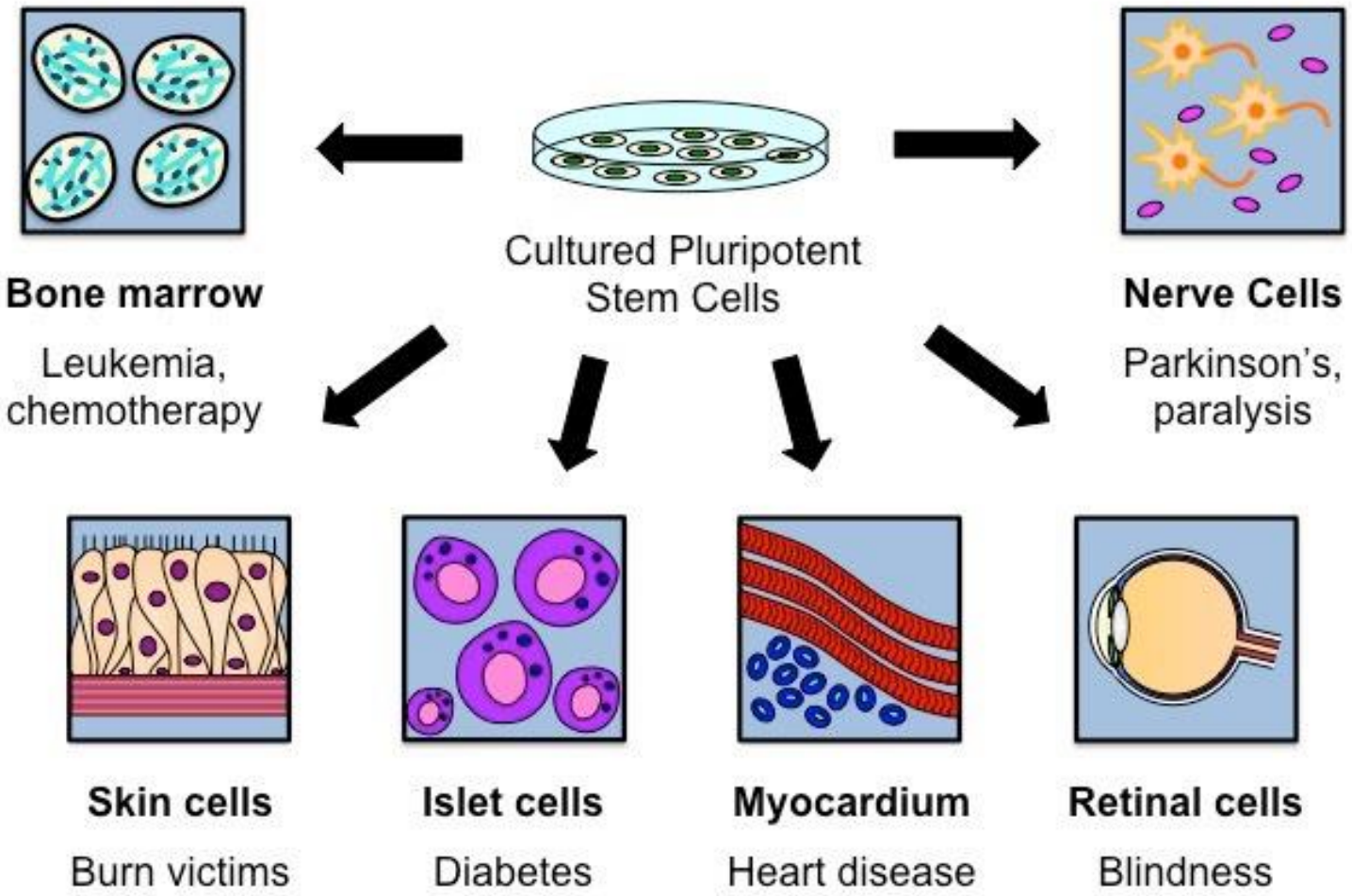
Unipotent – Can not differentiate, but are capable of self renewal

USE OF STEM CELLS

Stem cells can be used to replace damaged or diseased cells with healthy, functioning ones



EXAMPLES OF STEM CELL USE



ETHICS OF STEM CELL USE

	Harvesting	Potency	Tumor Risk	Limitations
Embryos	Are specially created (SCNT)	Highest	Higher	Involves destruction of an embryo
Umbilical Cord Blood	Easy to extract cells from cord	Lower	Lower	Cells must be stored from birth at cost
Adult Tissues	Cells obtainable at any life stage	Lowest	Lower	May be difficult to extract (and painful)

DISCUSSION STEM CELLS

Work in groups of 2 or 3 people and discuss whether or not you think the use of stem cells is justifiable. Write down your key arguments.

These questions/statements should give you an input/help you get the discussion rolling.

- When does a human life begin? (death of embryos when stem cells are taken)
- In vitro fertilization (IVF) in order to obtain stem cells, no human that would otherwise have lived has been denied its chance of living. Is it unethical to create human lives solely for the purpose of obtaining stem cells ?
- Have potential to allow new methods of treatments (incurable diseases?!) Could reduce suffering of other individuals