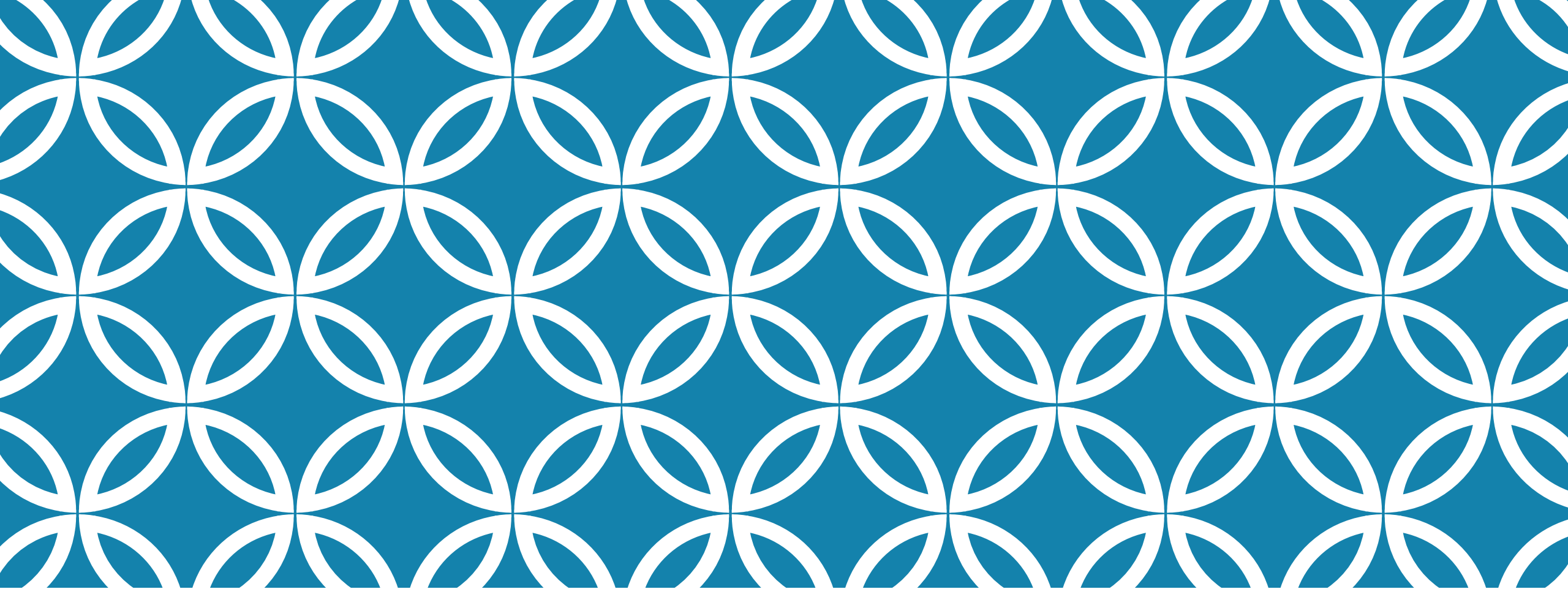




# CHAPTER 4.1

Cell Theory

# „SPONTANEOUS GENERATION“

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

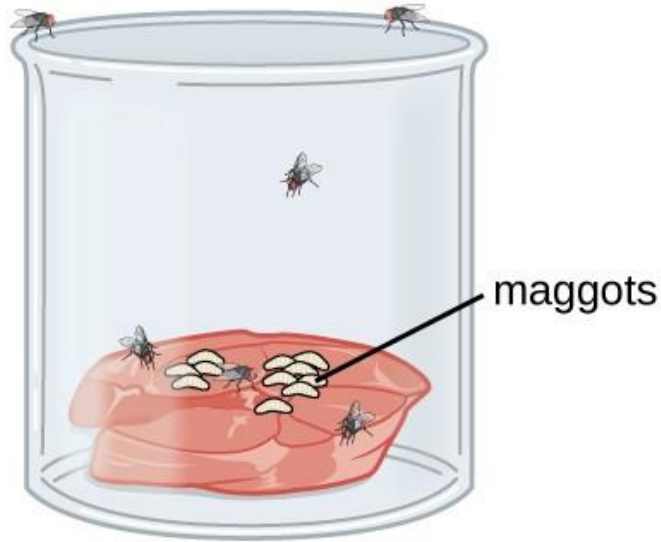
# JAN BAPTISTA VAN HELMONT'S RECIPE FOR MICE

„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



open container



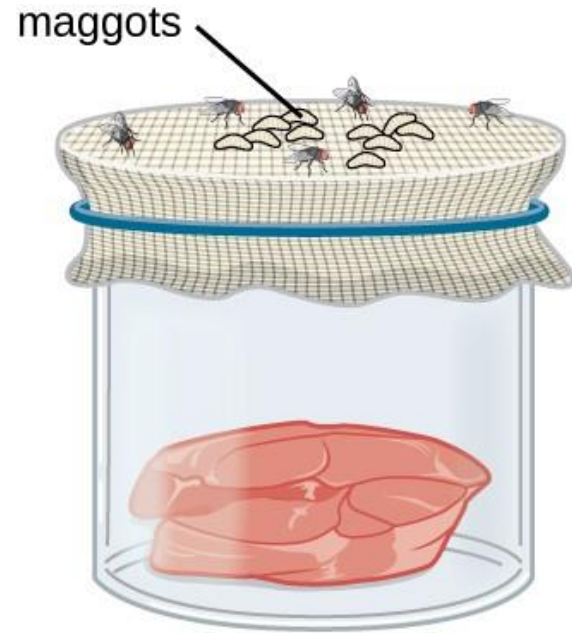
formation of maggots  
in meat



cork-sealed container



no formation of maggots  
in meat



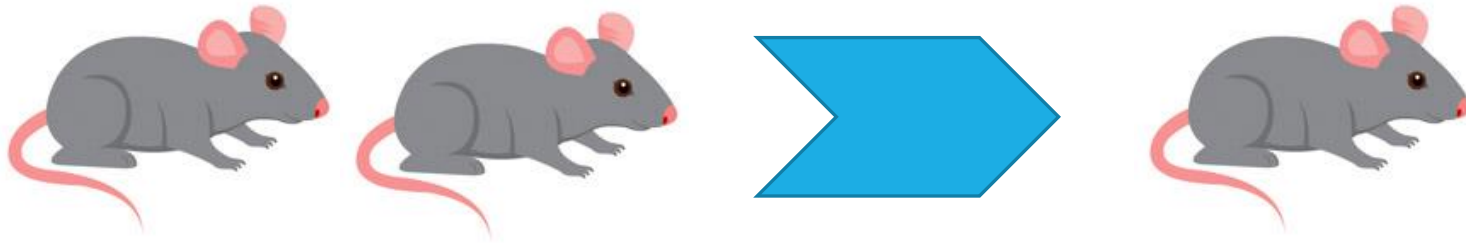
gauze-covered container



no formation of maggots  
in meat

# THE CELL THEORY

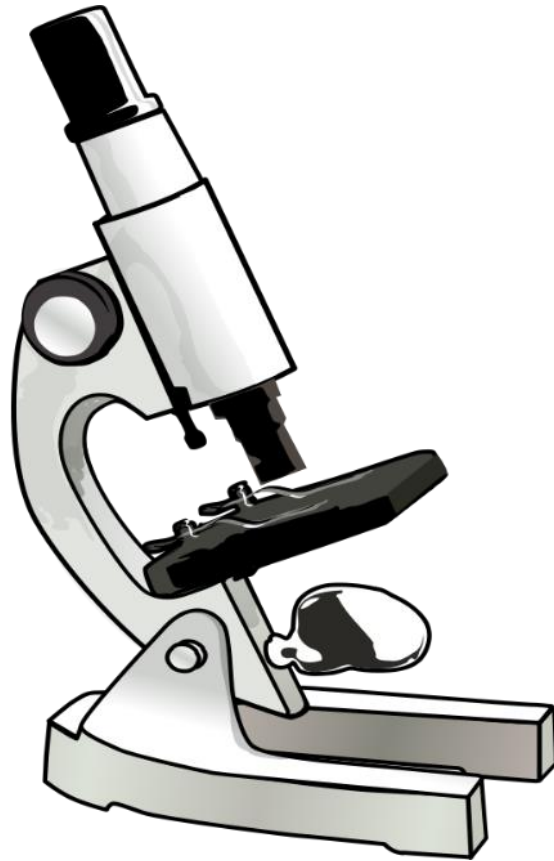
Scientists finally realized life only comes from other life



# 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 although 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 from 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.**



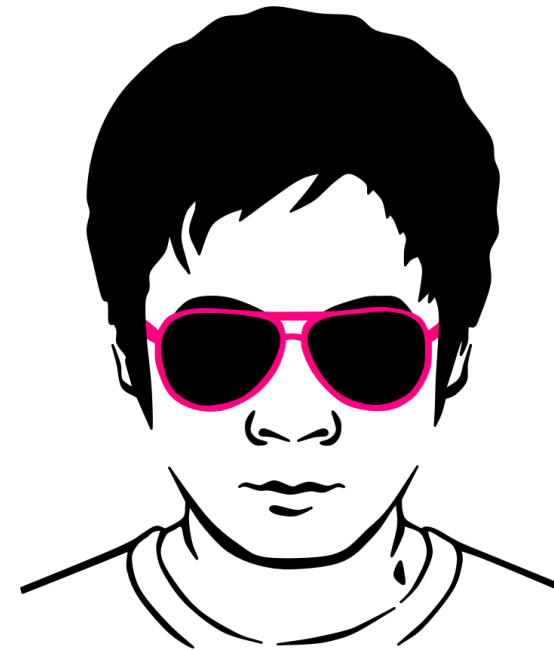
**WHERE DID THE FIRST CELL COME  
FROM?**

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 PARAMECIUM



# LIFE FUNCTION CHLORELLA

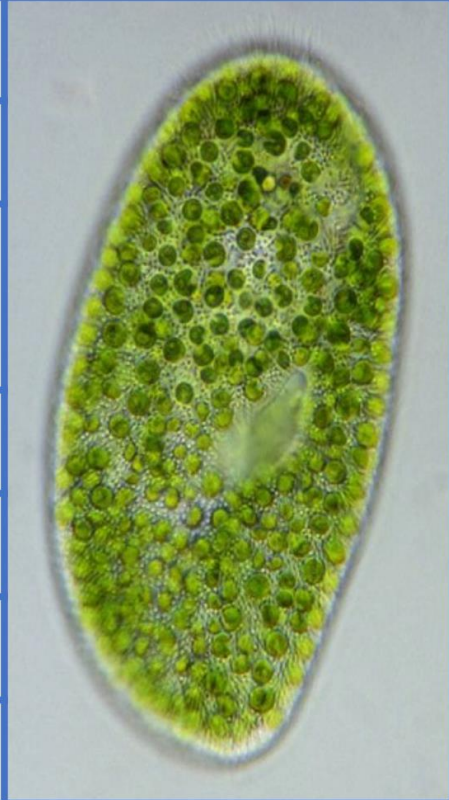




# LIFE FUNCTION EXAMPLES

| Paramecium                                                                         |  |   | Chlorella |                                                                                      |
|------------------------------------------------------------------------------------|--|---|-----------|--------------------------------------------------------------------------------------|
|  |  | M |           |  |
|                                                                                    |  | R |           |                                                                                      |
|                                                                                    |  | S |           |                                                                                      |
|                                                                                    |  | H |           |                                                                                      |
|                                                                                    |  | E |           |                                                                                      |
|                                                                                    |  | N |           |                                                                                      |
|                                                                                    |  | G |           |                                                                                      |
|                                                                                    |  |   |           |                                                                                      |

# LIFE FUNCTION EXAMPLES

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



# ARE VIRUSES ALIVE?

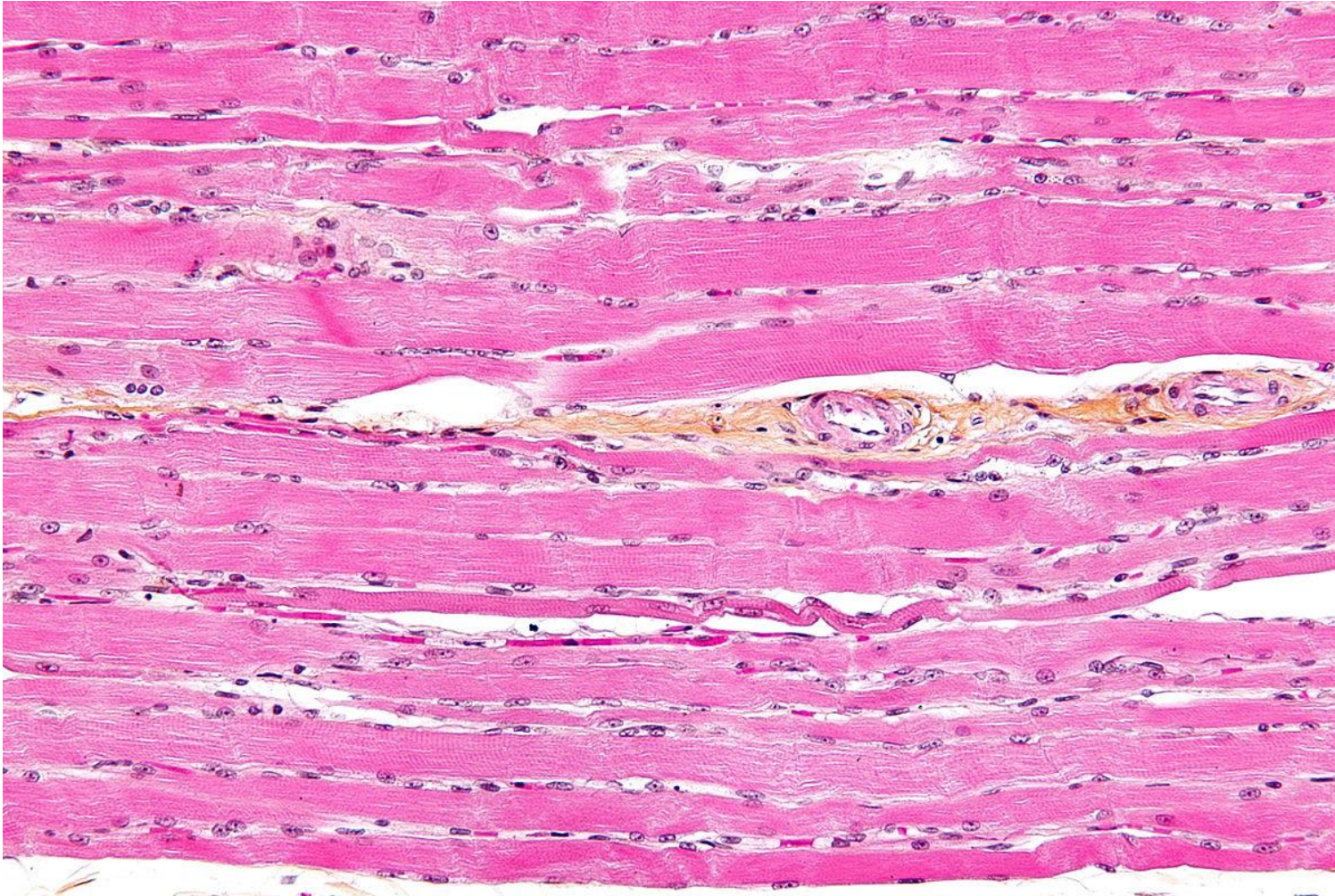
not cells

DNA or RNA wrapped up in protein coat

Few other living characteristics

Require a host to survive

# QUESTIONING THE CELL THEORY:



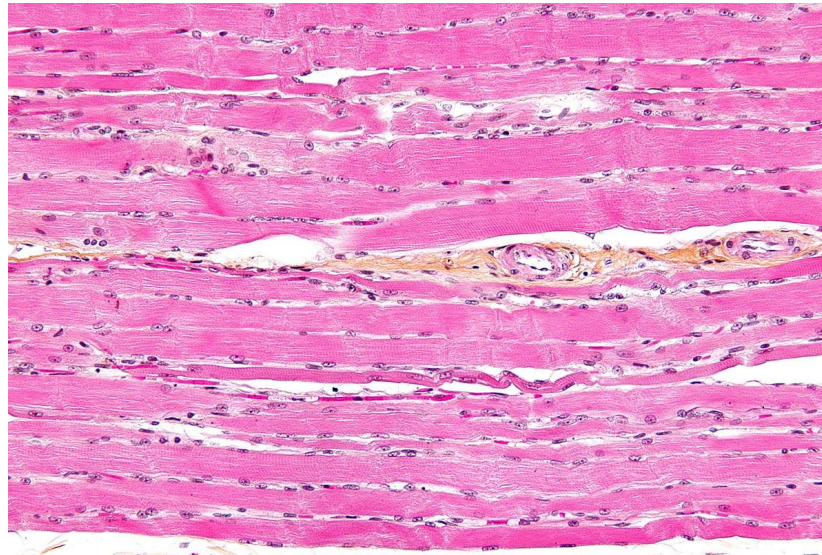
striated muscle tissue

# 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



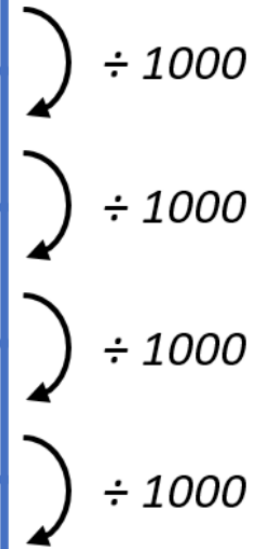
To calculate the actual size of a drawing or image, use the following calculation:

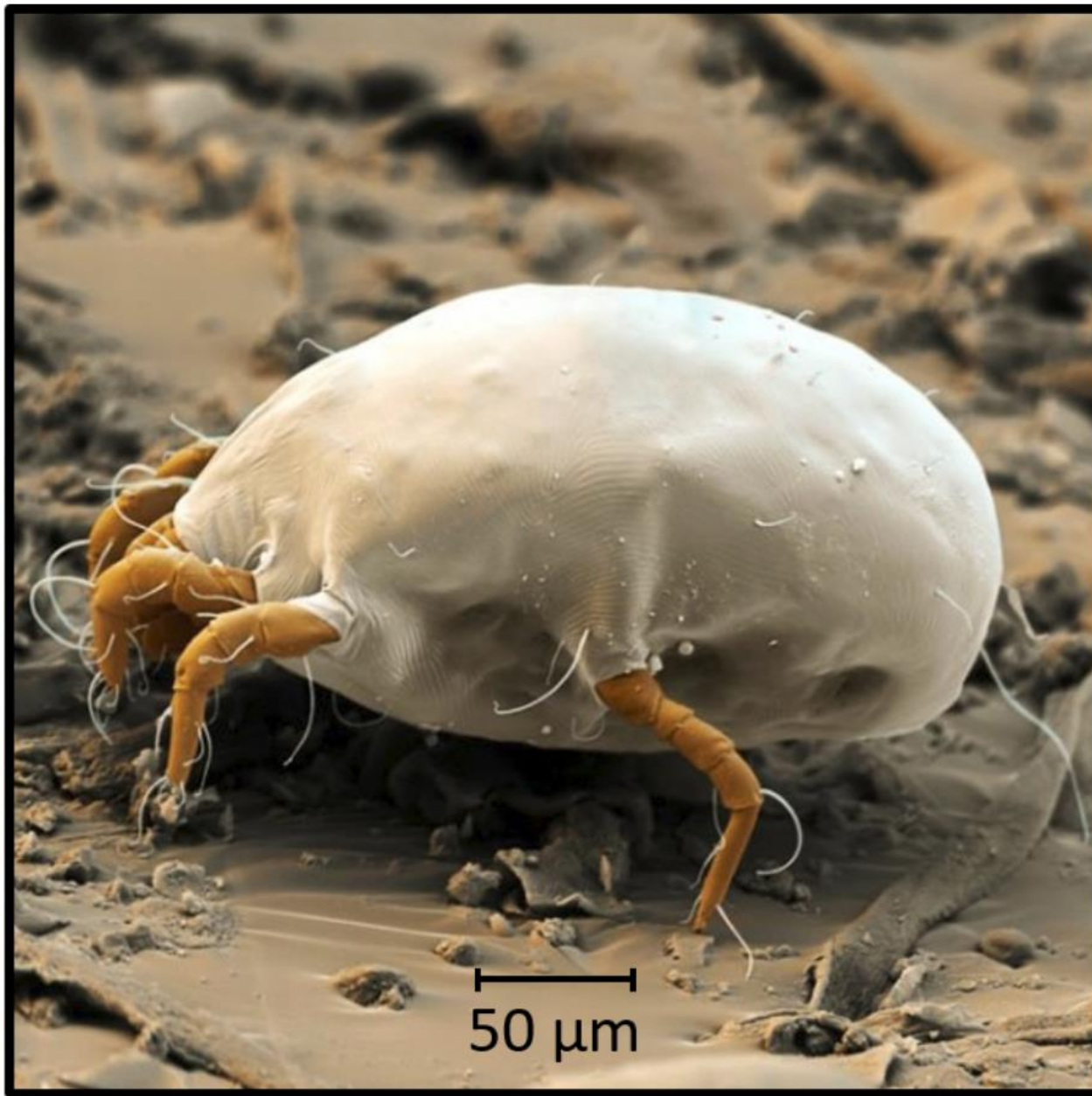
- **AIM:** **A**ctual size = **I**mage size ÷ **M**agnification



# REVISION: THE METRIC SYSTEM

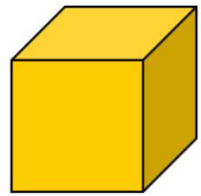
| Unit       | Prefix       | Symbol        |
|------------|--------------|---------------|
| <b>1</b>   | <b>metre</b> | <b>m</b>      |
| $10^{-3}$  | milli        | mm            |
| $10^{-6}$  | micro        | $\mu\text{m}$ |
| $10^{-9}$  | nano         | nm            |
| $10^{-12}$ | pico         | pm            |



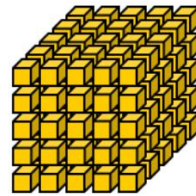


Total length = 13 cm

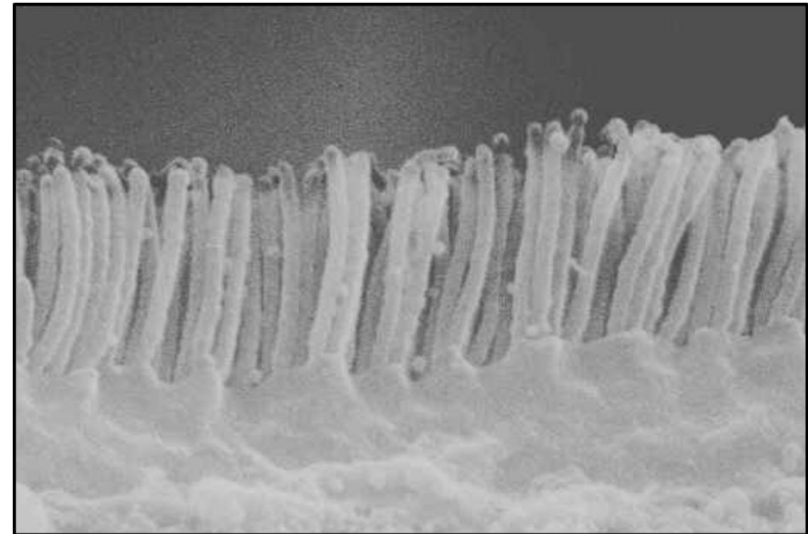
# SURFACE AREA : VOLUME RATIO



*Surface area increases  
Volume stays constant*

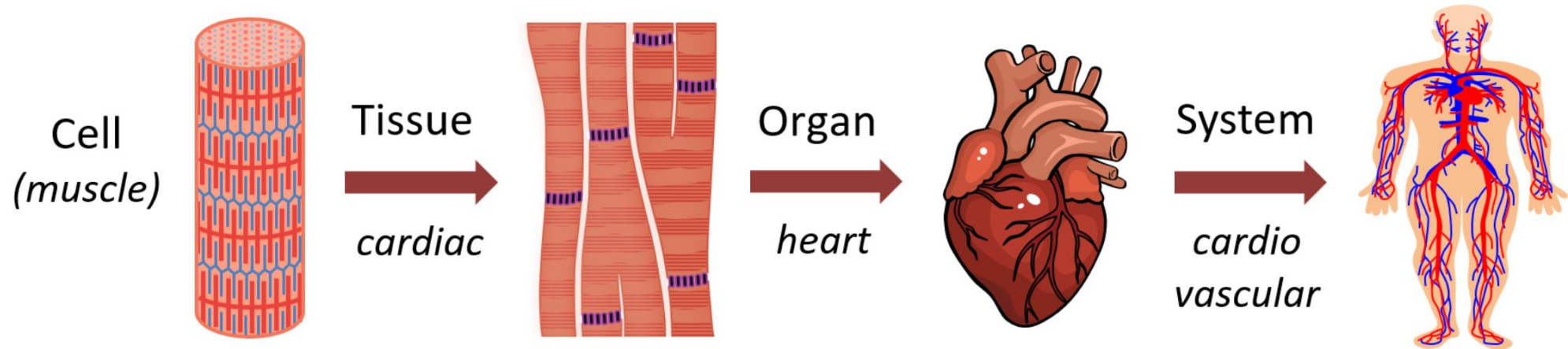


|     |                                                                            |     |
|-----|----------------------------------------------------------------------------|-----|
| 150 | <b>Total surface area</b><br>(height × width × sides<br>× number of boxes) | 750 |
| 125 | <b>Total volume</b><br>(height × width × length<br>× number of boxes)      | 125 |
| 1.2 | <b>SA:Vol ratio</b><br>(surface area ÷ volume)                             | 6   |



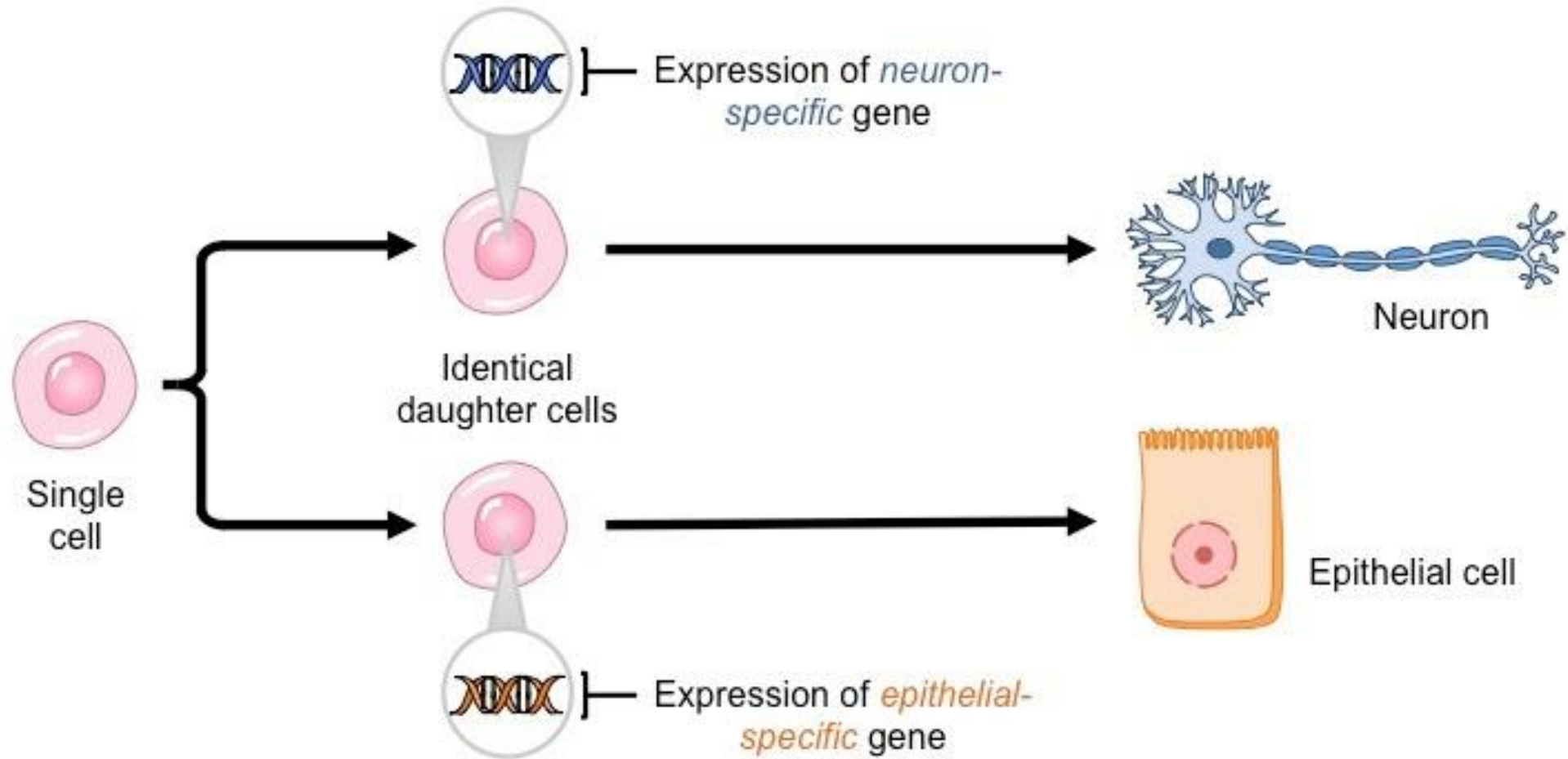
Cells / tissues may increase their surface area to optimise transfer  
(e.g. *microvilli* = ↑ SA:Vol ratio)

# MULTICELLULAR ORGANISMS

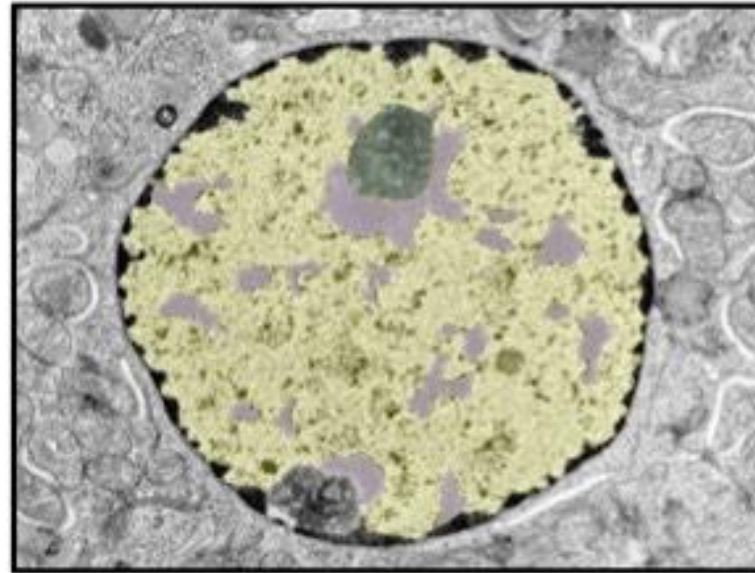
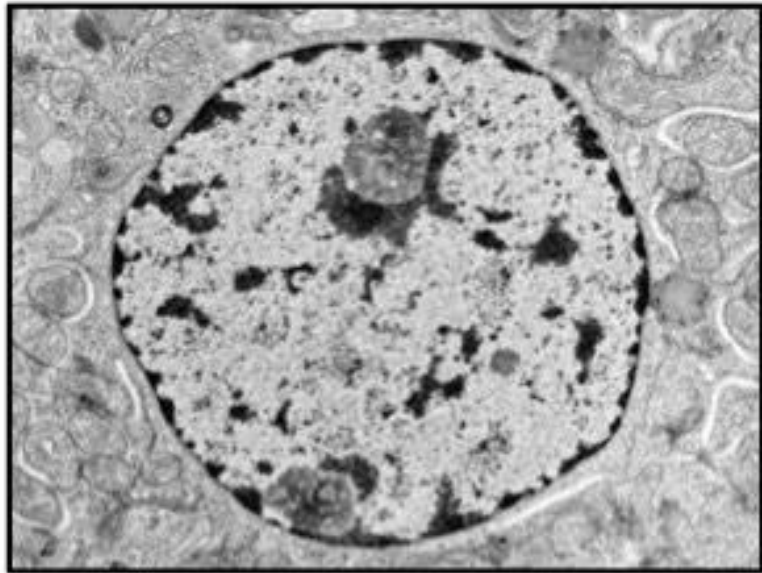




# CELL DIFFERENTIATION



# GENE PACKAGING



Nucleolus



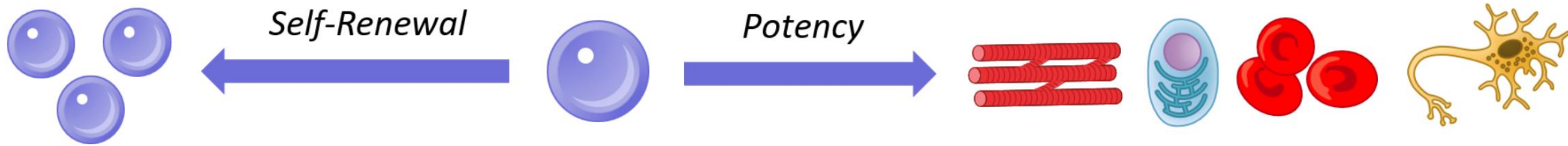
Heterochromatin



Euchromatin

# 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

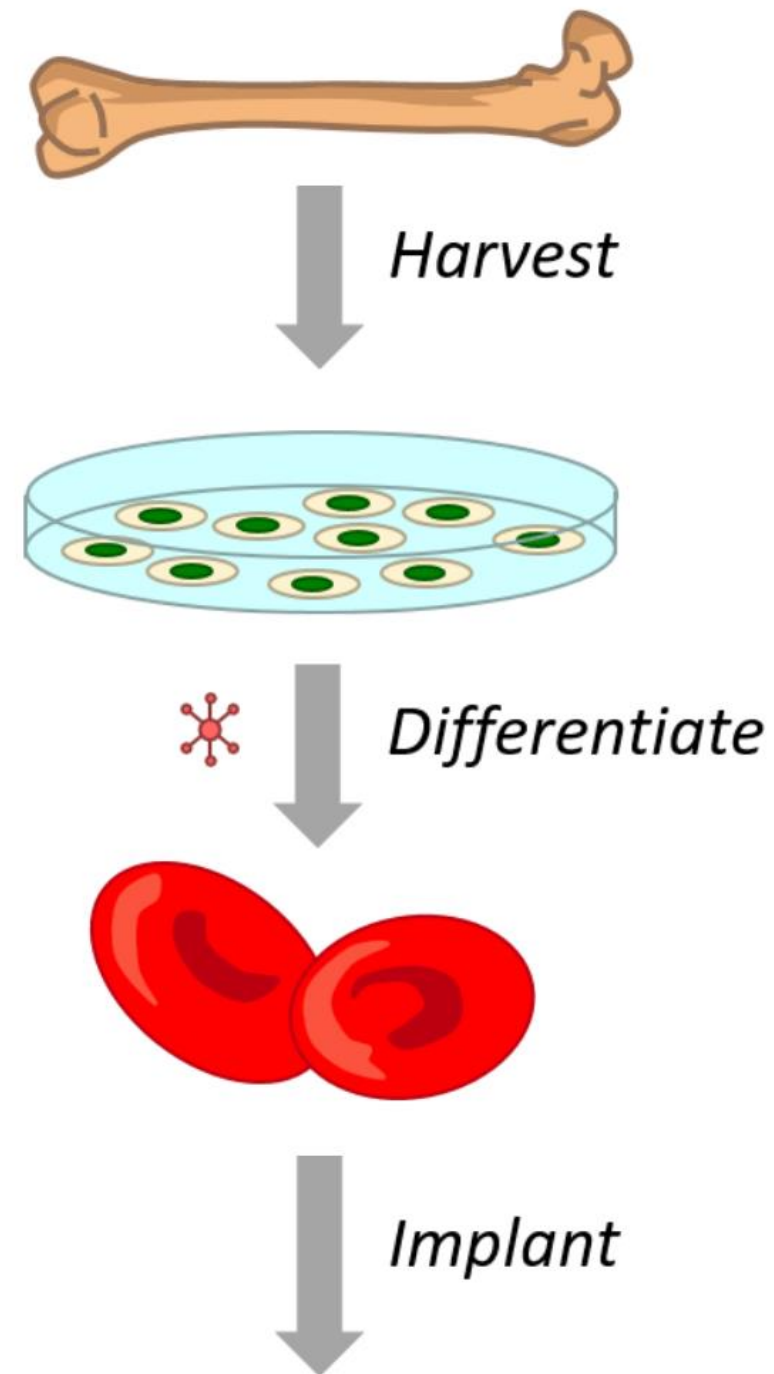
Pluripotent – Can form any cell type

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

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

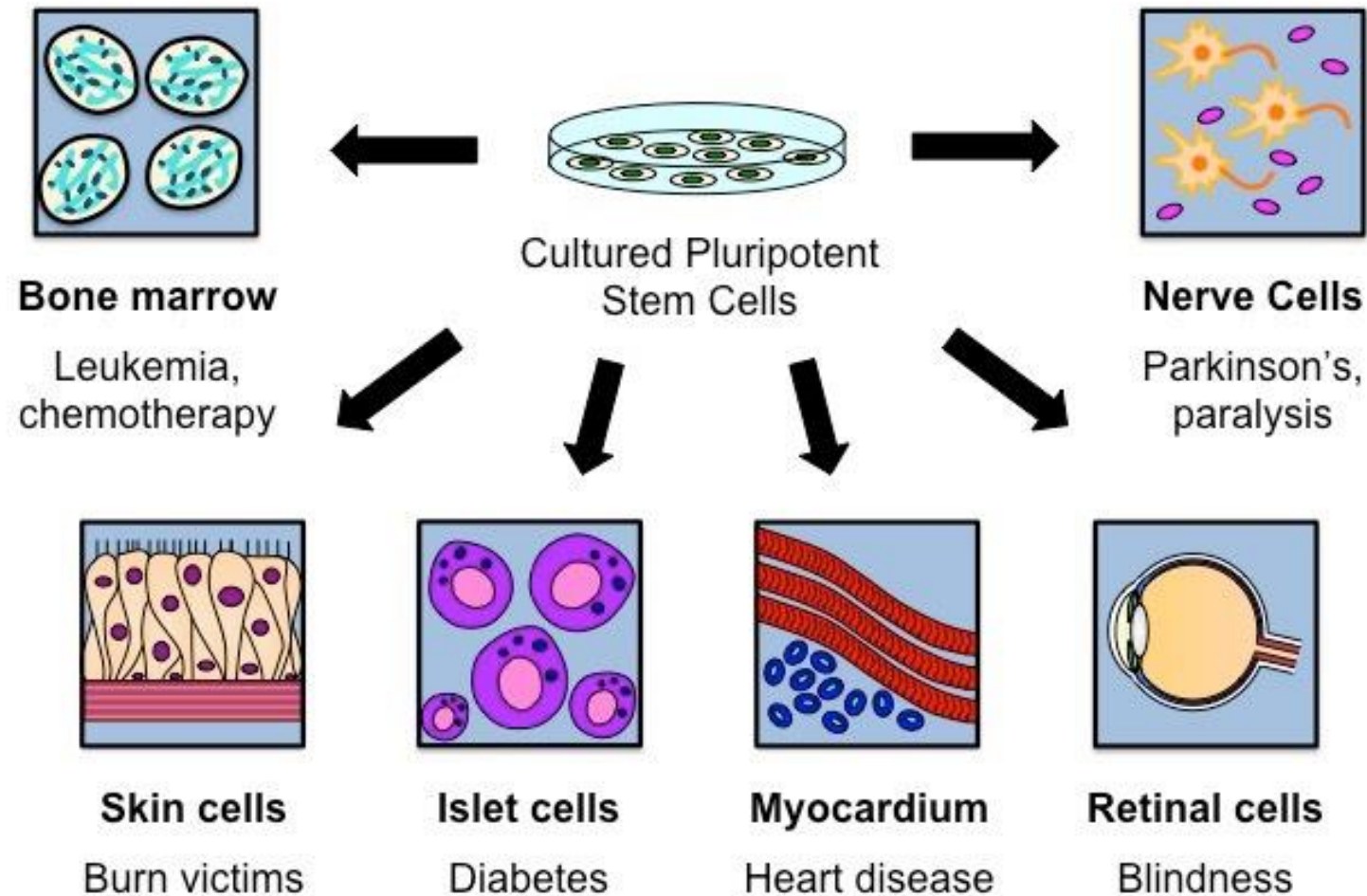
# USE OF STEM CELLS

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