Name:_____ **Class:**_____

2 The cell as the basic unit of life

2.1 Chemicals of life

1 **Inorganic** (無機的) chemical constituents (化學成分) of organisms:

Example		Function
Water		- As a reactant (反應物) - As a medium for chemical reactions to take place - As a medium of transport - As a cooling agent (冷卻劑) - Provides support and buoyancy (浮力)
Inorganic ions (無機離子)	Nitrate (硝酸鹽)	- As a source of nitrogen (氮) in plants for the synthesis of proteins
	Magnesium (鎂)	- As a component of chlorophyll (葉綠素) in plants - Involved in activating some enzymes (酶)
	Calcium (鈣)	- As a main component of bones and teeth
	Iron (鐵)	- As a component of hemoglobin (血紅蛋白) in red blood cells

2 **Organic** (有機的) chemical constituents of organisms:

Biomolecule (生物分子)	Type of atoms contained*	Example and function
Carbohydrates (碳水化合物)	C, H, O	- Glucose (葡萄糖) is broken down directly to release energy. - Starch (澱粉) is an energy reserve (能量儲備) in plants. - Cellulose (纖維素) is the main component of plant cell walls.
Lipids (脂質)	C, H, O	- Triglycerides (甘油三脂) are an energy reserve in our body; also help reduce heat loss and protect the internal organs. - Phospholipids (磷脂) are the component of cell membranes.
Proteins (蛋白質)	C, H, O, N (and S in some proteins)	- Proteins make up many body tissues. - Enzymes (酶) speed up reactions in our body. - Antibodies (抗體) defend our body against diseases.
Nucleic acids (核酸)	C, H, O, N, P	- Deoxyribonucleic acid (DNA) carries genetic information. - Ribonucleic acid (RNA) is involved in protein synthesis.

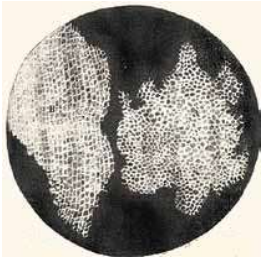
* C = carbon, H = hydrogen, O = oxygen, N = nitrogen, S = sulphur, P = phosphorus

2.2 Studying cells using microscopes

1. **Discovery of cells**

In 1665, Robert Hooke examined a thin slice of cork with a microscope. He named the small irregular boxes he saw 'cells', which were actually the cell walls of dead cork cells.

drawing of cork 'cells▶



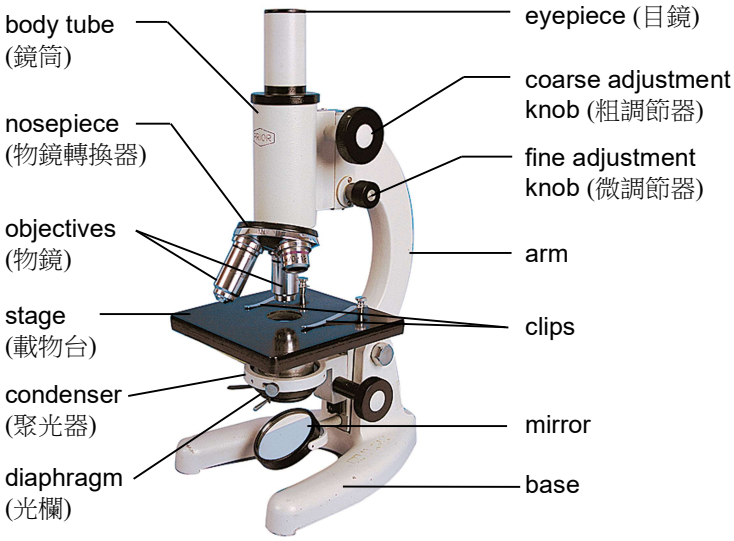
2. The **Cell Theory** (細胞學說) states that:

1. The cell is the basic unit of life .
2. All organisms are made up of one or more cells.
3. All cells come from pre-existing cells.

Light microscopes (光學顯微鏡) and **electron microscopes** (電子顯微鏡) are two common types of modern microscopes.

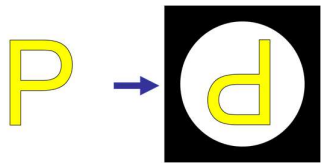
Type of microscope		Feature
(5) Light microscope (光學顯微鏡)		Light is used to form an image Magnification: up to 1000 times
Electron microscope	(6) Transmission electron microscope (透射電子顯微鏡)	Electron beams pass through the specimen to form an image. Used to study the internal structure of a specimen. Produces two-dimensional, black and white images. Magnification: up to 1500000 times
	(8) Scanning electron microscope (掃描電子顯微鏡)	Electron beams scan over the surface of the specimen to form an image. Used to study the external structure of a specimen Produces three-dimensional, black and white images Magnification: up to 300000 times

3. Different parts of a light microscope:



4. The image shown in microscope

Converted and inverted.



5. Magnification (放大率) of a light microscope:

$$\text{Total magnification of the light microscope} = \text{magnification of eyepiece} \times \text{magnification of objective}$$

$$\text{Magnification} = \frac{\text{size of the image}}{\text{size of the object}}$$

6. Basic steps of observation with a light microscope:

a **Low-power** magnification:

- Select a low-power eyepiece and a low-power objective. Adjust the brightness of the field of view.
- Clip a specimen onto the stage. Watch from the side. Lower the body tube by turning the coarse adjustment knob until the objective **nearly** touches the slide.
- Look through the eyepiece. Slowly raise the body tube by turning the coarse adjustment knob. Focus with the fine adjustment knob.

b **High-power** magnification:

- Focus the specimen with a low-power objective.
- Watch from the side and rotate the nosepiece to select a high-power objective.
- Focus with the fine adjustment knob.

2.3 The basic structure of a cell
Let's draw the structure of animal and plant cells

The structure of animal cell

The structure of plant cell

1. Functions of different sub-cellular structures (亞細胞構造):

Sub-cellular structure	Function
Cell membrane	- Thin and flexible - Encloses the cell and separates the cell contents from the outside environment. - Differentially permeable(差異透性的) to control the movement of substances in and out of the cell
Cytoplasm	- Holds many **organelles** (細胞器) - As a site for many **chemical reactions** - Allows the **movement** and **transport** of materials inside the cell
Nucleus	- Contains DNA, which carries genetic information that **controls activities** of the cell
Mitochondrion	- As the main site for the energy-releasing stage of **respiration**(呼吸作用)
Rough endoplasmic reticulum (rough ER)	- Has ribosomes; involved in the synthesis of proteins
Smooth endoplasmic reticulum (smooth ER)	- Does not have ribosomes; involved in the synthesis of Lipids
Vacuole	- Contains water and dissolved substances. - Provides support to the **plant** when it is full of water
Cell wall	- Protects, **supports** and **gives shape** to the **plant cell**
Chloroplast	- Contains chlorophyll which absorbs light energy for photosynthesis

2. Differences between animal cells and plant cells:

	Animal cell	Plant cell
Size	- Smaller	- Larger
Shape	- Usually irregular	- Fixed by the cell wall
Structure	- No cell wall - Has **small** or **no vacuoles** - No chloroplasts	- Has a **cell wall** - Often has a **large central vacuole** - Some plant cells have **chloroplasts**
Position of nucleus	- Usually in the centre of the cell	- May be located on one side of the cell

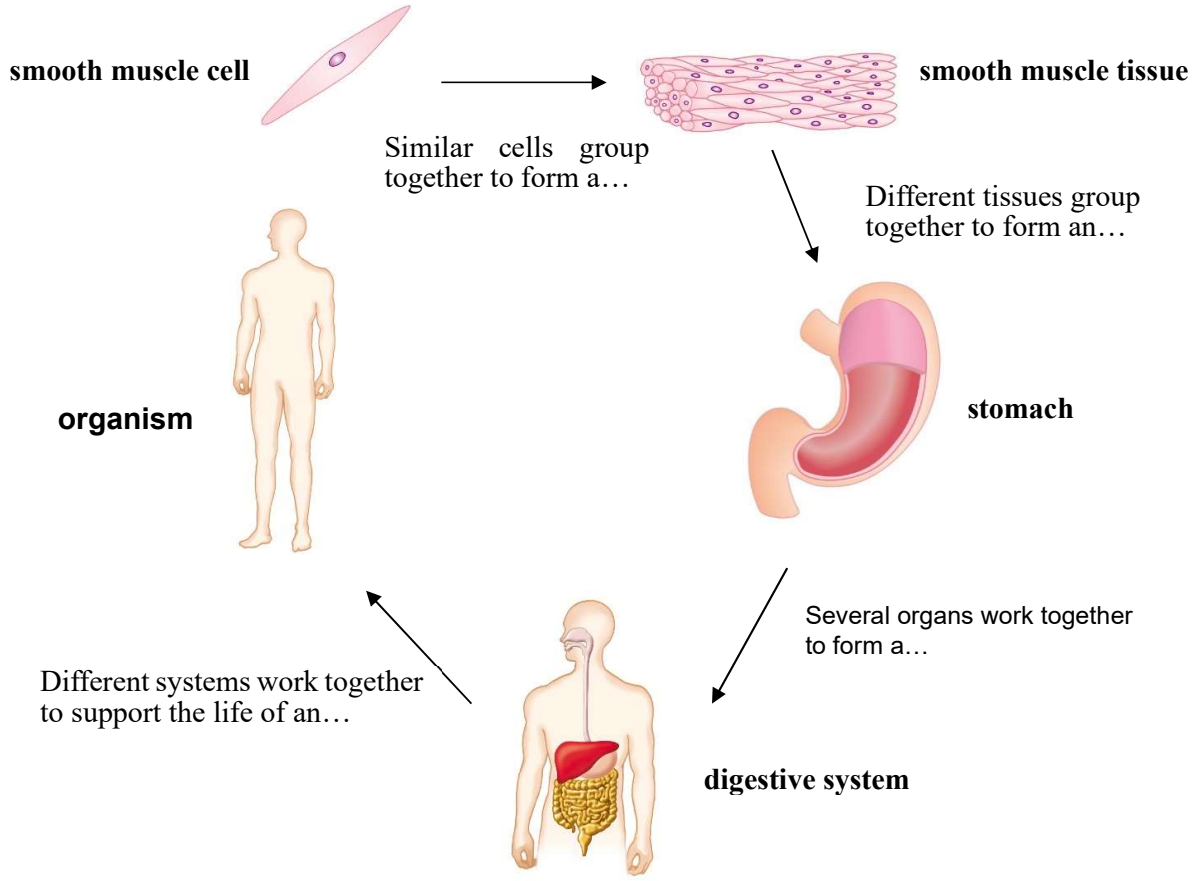
3. When preparing temporary mounts of **animal cells and tissues** for microscopic examination, **methylene blue solution** (亞甲藍溶液) is commonly used to stain the cells or tissues for clearer observation.

4. When preparing temporary mounts of **plant cells and tissues** for microscopic examination, **iodine solution** (碘液) is commonly used to stain the cells or tissues for clearer observation.

2.4 Levels of body organization

1. Division of labour among different kinds of cells is commonly found in **multicellular organisms** (多細胞生物).

2. Cells in an organism work together at different levels of organization:

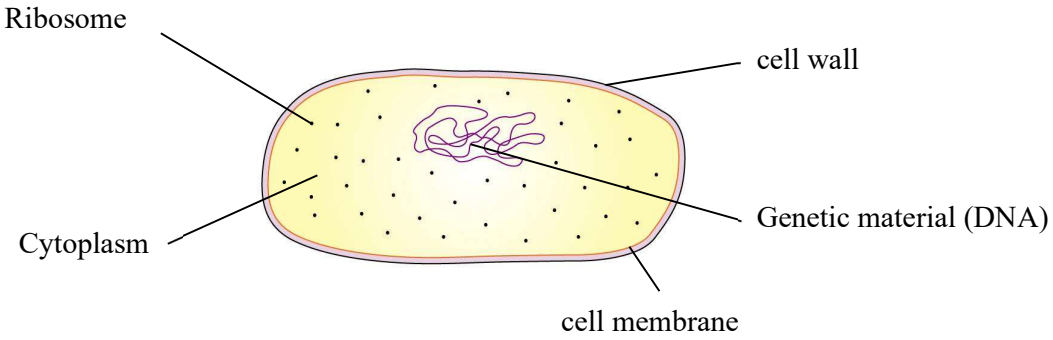


Cell → Tissue → Organ → System → Organism

2.5Prokaryotic and eukaryotic cells

1. Animal cells and plant cells have a true nucleus surrounded by the nuclear membrane (核膜). They are eukaryotic cells (真核細胞).

2. Some unicellular species (單細胞生物) (e.g. bacteria) do not have a true nucleus. They are prokaryotic cells (原核細胞).



▲ Basic structure of a prokaryotic cell (e.g. a bacterium)

- **Both** prokaryotic cells and eukaryotic cells are bounded by a **cell membrane**. Their genetic material is **DNA**.
- Differences between prokaryotic cells and eukaryotic cells:

	Prokaryotic cell	Eukaryotic cell
Size	Usually smaller	Usually larger
True nucleus	Absent	Present
Genetic material	DNA lying free in the cytoplasm	DNA enclosed in the nucleus
Cell wall	May be present or absent Does not contain cellulose	Present in plant cells; absent in animal cells Contains cellulose
Organelles bounded by a double membrane (e.g. mitochondria)	Absent	Present
Endoplasmic reticulum	Absent	Present
Ribosomes	Lying free in the cytoplasm	Some attached to rough endoplasmic reticulum, some lying free in the cytoplasm