CELL THEORY

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FUNCTIONS OF LIFE

All living things carry out seven basic functions integral to survival:

- **Metabolism:** Living things undertake essential chemical reactions
- **Reproduction:** Living things produce offspring, either sexually or asexually
- **Sensitivity:** Living things are responsive to internal and external stimuli
- **Homeostasis:** Living things maintain a stable internal environment
- **Excretion:** Living things possess the capacity to remove waste products
- **Nutrition:** Living things exchange materials / gases with the environment
- **Growth / Movement:** Living things can move and change shape or size

CELL THEORY

The cell theory describes the structural organisation of all living things. According to the cell theory:

- The cell is the smallest unit of life (unicellular organisms are capable of all seven functions of life)
- All living things are composed of cells (or their cellular products – such as hair, nails, etc.)
- Cells only arise from pre-existing cells (spontaneous generation of life is no longer possible on Earth)

CELLS

All cells share four basic features:

- They are enclosed by a **membrane**, which separates internal contents from the external environment
- They contain an internal fluid called the **cytosol**, in which various biological processes are able to occur
- There is **genetic material**, which functions as a set of instructions (i.e. a blueprint) for cellular activity
- They possess **ribosomes**, which function to translate specific genetic instructions within the cell

ATYPICAL CELLS

Certain types of eukaryotic cells do not conform to the standard organisation of a typical cell:

- Striated muscle fibres are formed from the fusion of individual muscle cells and so are **multinucleated**
- Aseptate fungal hyphae **lack internal partitions** between cells and so have a continuous cytoplasm
- Sieve tube elements are connected by plasmodesmata to form **supracellular assemblies** along the stem
- Red blood cells have **no nucleus** and lack the capacity to replicate (new cells produced by bone marrow)

CELL SIZE

Cells and their components are measured according to the metric system. Most cells will be measured in **micrometres** (10^{-6} metres), while subcellular components may be measured in **nanometres** (10^{-9} metres).

Unit	1	10–2	10–3	10–6	10–9
Prefix	metre (m)	centimetre (cm)	millimetre (mm)	micrometre (µm)	nanometre (nm)

MICROSCOPES

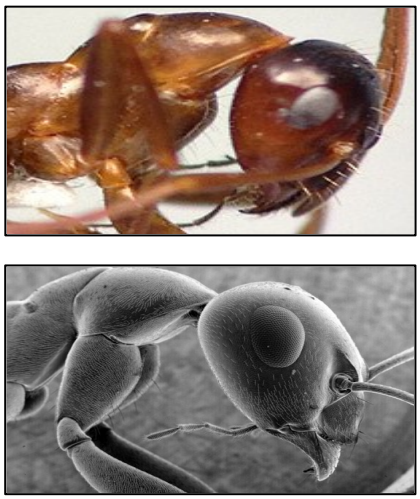
As cells are typically too small to view with the naked eye, they may be visualised instead via the use of microscopes (i.e. light versus electron).

Light Microscopy:

- Views living specimens in natural colour (uses lenses to bend light)
- Has a much lower resolution and magnification (roughly 100-fold)

Electron Microscopy:

- Views dead specimens in monochrome (uses electromagnets)
- Has a much higher resolution and magnification (can view in nm)
  - Transmission electron microscopes generate a cross-section
  - Scanning electron microscopes will render a 3D surface map



Light *(top)* vs **Electron** *(bottom)*

MICROSCOPE DEVELOPMENTS

The clarity of sub-cellular structures has been improved by a number of advancements in microscopy:

Immunofluorescence involves using antibodies that are conjugated to fluorescent probes to specifically target a cellular component of choice. The fluorescent probe can be conjugated to the targeting antibody (*direct* immunofluorescence) or a generic secondary antibody that binds to the targeting antibody (*indirect* immunofluorescence). The cell component can be visualised under a light microscope using relevant filters.

Cryogenic electron microscopy involves freezing biological specimens prior to visualisation with an electron microscope. This allows for the determination of molecular structures at near atomic resolution without requiring the crystallisation of the specimen. If the frozen specimen is physically broken along a specific plane via **freeze fracturing**, then internal cellular structures can also be studied at high resolution.

MAGNIFICATION

To calculate the linear **magnification** of a drawing or image, the following calculations may be used (mnemonic = MIA):

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

To calculate the **actual size** of a specimen within an image, the following calculations may be used (mnemonic = AIM):

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

Any calculation requires all sizes (image and actual) to be in the same units (e.g. both represented by micrometres)

EXAMPLE: COMMON DUST MITE

Image = 6.3 cm **Actual** = 350 µm

Magnification = × 180 *(63,000 ÷ 350)*