

Campbell Biology
Chapter 6: A Tour of the Cell

A1: The Fundamental Units of Life

- Cells are the fundamental unit of life, just as atoms are the fundamental unit of chemistry
- The cell is the simplest collection of matter that can be alive, so all organisms are made up of cells
- Many organisms are multicellular with interdependent specialized cell systems that work together
- The cell is the basic unit of structure and function
- Cells have been modified and have evolved throughout history, albeit they share common features

A1: Biologists use Microscopes and the Tools of Biochemistry to Study Cells

- Cells need to be studied via instruments because they cannot be seen by the naked eye

A2: Microscopy

- Microscopes and cells were first observed during the Renaissance
- **Light microscopes (LM)** are microscopes in which visible light is passed through the specimen and then through glass lenses; the lenses refract the light so the image of the specimen can be seen
- Magnification, resolution, and contrast are three important parameters in microscopy
- Magnification is the ratio of an object's image size to its real size
 - Light microscopes magnify objects 1000 times, so additional details can be seen
- Resolution is a measure of the clarity of the image; it is the minimum distance two points can be separated and still appear as such
 - Light microscopes cannot resolve detail finer than 200 nanometers
- Contrast is the difference in brightness between the light and dark areas of an image
 - Labelling cell components/staining helps to enhance contrast
- Resolution limited the study of **organelles**, which are membrane-enclosed structures within eukaryotic cells
- The **electron microscope (EM)** focuses a beam of electrons through a specimen or onto its surface
 - Resolution is inversely related to wavelength of electrons/light
 - Most modern electron microscope can resolve structures to about 2 nm
- The **scanning electron microscope (SEM)** is used for studying the topography of a cell
 - The electron beam scans the surface of the sample coated in gold, which excites the electrons, which is further detected by a machine that translates the excitement to a three-dimensional image
- The **transmission electron microscope (TEM)** is used to study the internal structure of cells
 - An electron beam is aimed through a thin section of the specimen, just like light through a slide
 - The specimen is stained with atoms of heavy metals, which attach to cellular structures, which changes the cellular density of some areas
 - The electrons are dispersed more in the denser regions, so the pattern of transmitted electrons is displayed as an image
- Both SEM and TEM use electromagnets to bend the paths of the electrons to create an image
- Electron microscopes allow subcellular components to be discovered, but only light microscopes can observe living cells, and specimen preparation can introduce structures that are not original
- Labelling cellular structures with markers has made it possible to see greater detail in light microscopes
- Confocal and deconvolution microscopy produce sharp three-dimensional images
- Super-resolution microscopy refers to the techniques and labels that allows researchers to break the resolution barrier
- Cytology is the study of cell structure, and biochemistry is the study of chemical processes of cells

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