BIO 1

CELL

Fundamental unit of life

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HISTORICAL DEVELOPMENT OF THE MICROSCOPE

This Timeline will guide you through the Key events that paved the way to the existence of powerful microscopes we have today.

Year	Important Event
1590	Hans Janssen and his son, Zacharias Janssen, placed multiple lenses in a tube and found out that objects seen through the tube appear greatly enlarged.

HISTORICAL DEVELOPMENT OF THE MICROSCOPE

Year	Important Event
1609	Galileo Galilei invented a compound microscope using convex and concave lenses.
1625	This was the first time the term “microscope” was used by Giovanni Faber to refer to the compound microscope of Galilei.

HISTORICAL DEVELOPMENT OF THE MICROSCOPE

Year	Important Event
1665	Robert Hooke, an English physicist, coined the term “cell” in his publication, *Micrographia.* He was the first to see a plant cell under a single lens microscope.
1676	Antonie van Leeuwenhoek was the first to see living cells using his own single lens microscope. He examined blood cells, yeast, and insects.

Year	Important Event
1830	Joseph Lister reduced spherical aberrations by using several weak lenses together at certain distances to get a good magnification without blurring the image.
1874	Ernst Abbe introduced a mathematical formula that correlates resolving power to the wavelength of light. It made the calculation of the theoretical maximum resolution of the microscope possible.

Year	Important Event
1931	Ernst Ruska and Max Knoll designed and built the first transmission electron microscope. The electron microscope does not depend on light but on electrons. It can visualize objects as small as the diameter of an atom.
1932	Frits Zernike invented the first phase contrast illumination which allows the imaging of transparent samples. Objects can be seen even without staining.

HISTORICAL DEVELOPMENT OF THE MICROSCOPE

Year	Important Event
1942	Ernst Ruska invented the first scanning electron microscope. It transmits a beam of electrons across the surface of a specimen.
1957	Marvin Minsky introduced the principle of confocal imaging, which gives a resolution that is higher than that of conventional light.

Year	Important Event
1972	Godfrey Hounsfield and Allan Cormack developed the Computerized Axial Tomography (CAT) scanner. It can generate cross-sectional views and three-dimensional images of internal organs and structures.
1978	Thomas and Christoph Cremer developed the first practical confocal laser scanning microscope. This instrument uses focused laser beams to an objects.

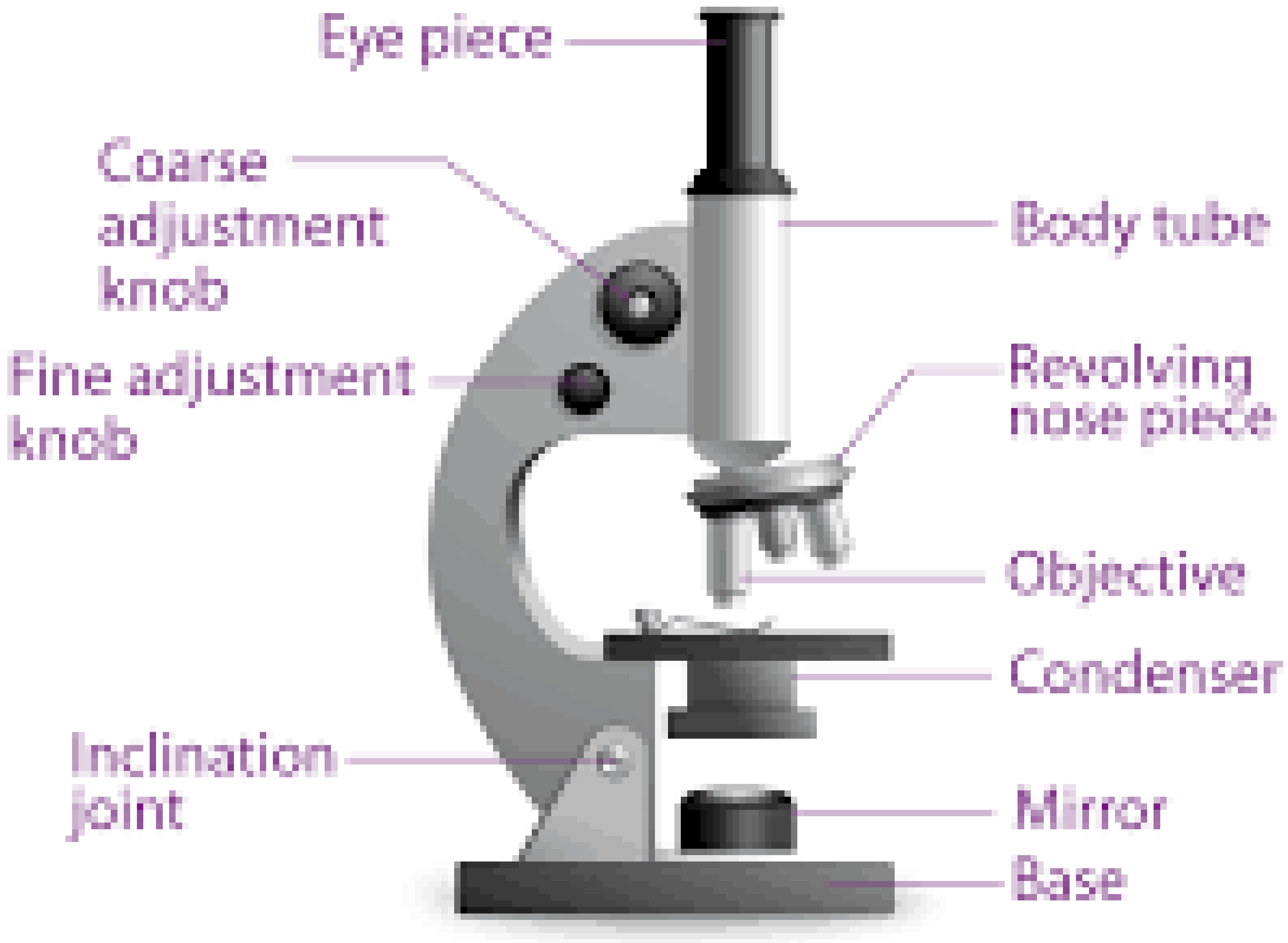
Year	Important Event
1981	Gerd Binnig and Heinrich Rohrer invented the scanning tunnelling microscope (STEM). It can visualize individual atoms within materials.
1986	Ernst Ruska won the Nobel Prize for his contributions to the study of microscopy. A Nobel Prize was also awarded to Gerd Binnig and Heinrich Rohrer.

Year	Important Event
1992	Douglas Prasher cloned the green fluorescent protein that he used in fluorescence microscopy.
1993-1996	Stefan Hell pioneered the first super-resolution microscopy.
2008	The first installation of the Titan 80-300 Cubed electron microscope in Canada has revolutionized nanotechnology, bringing it to newer, more exciting frontiers
2010	Researchers at the University of California, Los Angeles used a cryoelectron microscope to see the atoms of a virus.

Year	Important Event
2014	Eric Betzig, Stefan Hell, and William Moerner got the Nobel Prize in Chemistry for the super microscopes they invented. It can see matter smaller than 0.2 μm.
2017	For nearly two decades, three researchers, Jacques Dubochet, Joachim Frank, and Richard Henderson, created a technique for generating 3D structure of the protein at an atomic level using an electron microscope.

Year	Important Event
2018	Moving from 2D to 3D with Cryo-EM, Titan Krios, a high-end transmission electron microscope, was officially unveiled and inaugurated in 2018.It was developed by Thermo Fisher Scientific, an American company.

COMPOUND MICROSCOPE



THE PARTS OF THE MICROSCOPE AND THEIR FUNCTIONS

Most ordinary classroom laboratories use light compound microscopes to see living or preserved specimens and to give clear images of cells such as bacteria. This type of microscope can magnify specimens by up to about 1,000 times their original size, and specimens are often stained to make the images stand out.

One objective is a **lower-power lens.** It magnifies ten times and is marked 10x.

Ocular lens × Objective lens = Total magnification.
Example: 10x × 10x = 100x (100 times larger)

The second objective lens is a **high-power lens.** High-power objectives can magnify 40x on the common compound microscope model you are using.

THE PARTS OF THE MICROSCOPE AND THEIR FUNCTIONS

Ocular lens × Objective lens = Total magnification.
Example: 10x × 40x = 400x (400 times larger)

Resolution is the ability of a microscope to show the details of an object being examined. It refers to the shortest distance between two points on a specimen that can still be distinguished by the observer or camera system.

Contrast refers to the darkness of the background with reference to the specimen. Usually, lighter specimens could be seen clearly on darker backgrounds. In order to see colorless/transparent specimens, you need to use a phase contrast microscope, which is a type of microscope.

PARTS OF LIGHT MICROSCOPE

I. **Mechanical parts –** parts of the microscope that are involved in giving support or strength to the instrument. These are also the parts that are movable and can be adjusted.

a. Body Tube – a hollow tube through which light passes from the objective to the eyepiece
b. Revolving nosepiece – holds the objectives. It can be rotated to select the appropriate objective. The lenses must be “clicked” into place to successfully view a specimen.
c. Arm – connects the base and the body tube together. It serves as a handle for carrying the microscope.
d. Stage – the platform where the slide or specimen to be examined is placed. It has an opening at the center that allows light to pass from below to the specimen.

PARTS OF LIGHT MICROSCOPE

e. Stage clips – holds the slide in place

f. Base – the part where the microscope is firmly anchored. It gives support to the whole microscope and is the part where the illuminators are attached.

g. Inclination joint – a joint found in some microscopes at which the arm is attached to the pillar of the microscope. It is used for tilting the microscope.

PARTS OF LIGHT MICROSCOPE

II. **Illuminating Parts** – parts of the microscope that provide and capture light for illumination

a. Mirror – reflects light from the surroundings to the specimen on the stage. It is planar on one side and concave on the other. The concave side of the mirror is used for natural light, while the flat side is used for artificial light. It is supported by the mirror rack. In more modern microscopes, this is already replaced with a light source or a

PARTS OF LIGHT MICROSCOPE

b. Condenser – concentrates the light from the light source or mirror onto the object of specimen being studied. It is located below the stage, and it is held in place by a rack.

c. Iris diaphragm – regulates the amount of light that reaches the specimen. It is attached beneath the condenser.

III. **Magnifying Parts –** parts of the microscope that are involved in magnifying the image of the specimens, including the resolution

PARTS OF LIGHT MICROSCOPE

III. Magnifying Parts

a. Eyepiece or ocular – The part through which an observer look s to view a specimen. It usually has a magnification of 10x, through eyepiece with 5x to 30x magnification are also available.

b. Objectives – the main lenses that magnify the specimen being observed. Usually, microscopes have three objectives, but more modern ones house four or even five objectives. Typical objectives have magnifying power of 4x, 10x, 40x, and 100x.

CELL THEORY: THE UNIFYING FOUNDATION OF CELL BIOLOGY

In the 1820s, improvements in lens design provided more details in cell structures. It was Robert Brown, a botanist, who first observed the spherical structure in plant cells. He called this structure the “nucleus” of the cell. By 1839, Theodore Schwann, a zoologist, discovered the presence of cells in animal tissues, followed by the discovery of Matthias Schleiden, the botanist who conclude that all plant tissues are composed of cells.

CELL THEORY: THE UNIFYING FOUNDATION OF CELL BIOLOGY

More than a decade after the discoveries of Schwann and Schleiden, another German scientist, Rudolf Virchow, a physician by profession, studied the growth and development of cells and discovered that all cells arise from preexisting cells. The cell theory is one of the foundations or doctrines in the study of life. The observations made by these three scientists comprised the cell theory which includes the following tenets:

CELL THEORY: THE UNIFYING FOUNDATION OF CELL BIOLOGY

a. Cells are the smallest unit of life. All living things are composed of one or more cells.
b. Cells are the basic unit of organization of all organisms.
c. Cells come only from preexisting cells.

Modern cell theory adds two additional key points:

a. Cells carry and pass on to the offspring hereditary units during cell division.
b. All cells are relatively the same in terms of chemical composition and metabolic activity.

CELL THEORY: THE UNIFYING FOUNDATION OF CELL BIOLOGY

Cell Size

Most cells are microscopic; however, unfertilized bird eggs are typically large enough to be seen with the naked eye. Bacterial cells range about 1-10μm (microns or micrometers) in diameter. Most plant and animal cells are visible only under the microscope, ranging from a size of 10-50μm in diameter. These include the cells that comprise your body.

Cell Shape

Cells vary not only in size but also in shape. A cell's shape depends on its function. For example, most nerve cells are long, which are related to their functions of transmitting impulses from the central nervous system to the different parts of the body. A neuron or nerve cell has cytoplasmic extensions, such as axons and dendrites, that are important in the performance of its functions. Skin cells are flat cells that help cover the body from the external environment, while blood cells can change shape, helping them digest and kill disease-causing germs that invade the body.

Internal Organization

Cells also vary in terms of internal organization. The structural characteristics of a particular cell are closely related to its function. The diversity in cells could be seen between different species. Take, for example, a plant cell and animal cell. These two cells show great variations in parts because they function differently to perform specific tasks. Even a single human body carries several different kinds of cells. Each cell in the human body is specialized and adapted for a particular job. For example, glandular cells are different from muscle cells. Glandular cells produce secretory materials such as

Internal Organization

mucus and hormones, which is why they are provided with more ribosomes and Golgi bodies. Muscle cells, on the other hand, are provided with more mitochondria to produce more energy needed in muscle contraction.

Quiz 1.1

Directions: Choose the letter of the correct answer.

1. Who is considered the "English Father of Microscopy"?

a. Robert Hooke

b. Hans Janssen

c. Robert Brown

d. Rudolf Virchow

2. Which of the following is not a tenet of the cell theory?

a. All living things are made up of cells.
b. All living things are composed of atoms.
c. All cells come from preexisting cells.
d. Cells are the basic functional unit

3. What part of the microscope focuses the light on the specimen being observed?

a. Mirror c. condenser

b. Objective lens d. ocular

4. Who was the Dutch microscope maker who pioneered the study of protozoa?

a. Louis Pasteur c. Galileo Galilei

b. Robert Hooke d. Anton van Leeuwenhoek

5. Which of the following is measured in cubic centimeters?

a. Area

b. Volume

c. Weight

d. Height

B. Application and Analysis

1. Why are the cells of giraffes not larger than those of a mouse?
2. Leeuwenhoek's microscope revealed microscopic organisms he called "animalcules", yet he never concluded that the cells are the smallest unit of living organism. What could be the reason for this?
3. It is said that the cell theory is a cornerstone in biology. Why do you think this is so?

THANK YOU!

Any questions?