MICROSCOPIC LIFE

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Learning outcomes

• Know all about a Microscope
  • Parts
  • Uses

• Microscopic life forms

• Usefulness of some important microscopic life forms

• Earn Microscopic Life Honour

• Pre-requisite for 'Blood and the Body's Defenses' Honour

• Health Master Award
Did you know that you can identify diseases by just looking down the microscope?
<table>
<thead>
<tr>
<th>Disease</th>
<th>Caused by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food poisoning</td>
<td>Salmonella, Shigella, E. coli</td>
</tr>
<tr>
<td>Common cold</td>
<td>Influenza virus</td>
</tr>
<tr>
<td>Malaria</td>
<td>Plasmodium species</td>
</tr>
<tr>
<td>Filaria</td>
<td>Nematode – Wuchereria bancrofti</td>
</tr>
<tr>
<td>Iron deficiency anaemia</td>
<td>Hypochromic microcytes &amp; pencil cells</td>
</tr>
<tr>
<td>Blood cancer</td>
<td>Blast cells – most immature blood cells</td>
</tr>
<tr>
<td>Bleeding disorder</td>
<td>Thrombocytopenia – lack of platelets</td>
</tr>
<tr>
<td>COVID-19</td>
<td>SARS-COV2</td>
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</tbody>
</table>
1. Types of Microscopes

1. Compound Microscope

2. Electron Microscope
1. Types of Microscopes

3. Dark Field Microscope
   - Uses optical microscopy illumination technique to enhance the contrast in unstained samples
   - Principle - illuminating the sample with light (not collected by the objective lens)
   - Produces classic appearance of a dark, almost black, background with bright objects on it

4. Fluorescence Microscope
   - Light microscope using the phenomena of fluorescence & phosphorescence instead of reflection and absorption
   - used to study properties of organic or inorganic substances
1. Types of Microscopes

- **Fluorescence** is the emission of light by a substance that has absorbed light or other electromagnetic radiation.
- **Phosphorescence** is a specific type of photoluminescence.
  - Does not immediately re-emit radiation it absorbs.
  - Most familiar form is "glow-in-the-dark". Ex:- hands of a watch.
5. Phase Contrast

- A contrast-enhancing optical technique
- Produces high-contrast images of transparent specimens
  - Does not require staining
- Uses: to study living cells, microorganisms, thin tissue slices & sub-cellular particles (including nuclei & other organelles)
2. Parts of a Microscope

- There are three structural parts of the microscope i.e. head, base and arm
- Eyepiece or ocular
  - The part of a microscope that a user looks into
  - Contains a lens called the ocular
  - Standard magnification is 10x
- Bodytube
  - Eyepiece holder
  - Connects the ocular lens to the objective lens
- Nosepiece
  - Part of the microscope that the objective lenses attach to
2. Parts of a Microscope

• Objective lens
  • Objectives produce most of the magnification
  • Various lenses are attached to the nosepice
  • 10x (lower power)
  • 20x (lower power)
  • 40x (higher power)
  • 100x (highest power – oil immersion lens)

• Stage
  • Holds the slide and contains an opening
  • The opening allows light to pass through the specimen
2. Parts of a Microscope

• Diaphragm
  • Located beneath the stage
  • Controls the passage of light onto the specimen

• Coarse adjustment knob
  • Moves the stage up and down quickly
  • Makes large changes in the focus
  • Used to find the specimen using the low power objective lens (10x or 20x)

• Fine adjustment knob
  • Used to make smaller focus adjustments
  • Brings specimen into sharp focus
  • Usually used while using high power objective lens (40x or 100x)
2. Parts of a Microscope

**Light source**
The light source illuminates the specimen by shining bring light

**Base**
Supports the microscope
Rest of the instrument rests

**Power switch**
Turns the light on and off
Parts of a Microscope
Natalie Maloney
Medical Scientist
St James Hospital
Dublin
3. How do you calculate the magnification?

• The magnification of the microscope is simply -
  • Magnification of the ocular lens times the magnification of the objective lens

• Magnification = Ocular X Objective

• Example
  • What is the total magnification of the microscope while using a 20x objective lens?
  • Eye piece = 10x
  • Objective = 20x
  • Magnification = 10 X 20
    = 200x
3. What is the total magnification of the microscope while using a 100x objective lens?

• Eye piece = 10x
• Objective = 100x
• Magnification = $10 \times 100 = 1000x$

• Total magnification is 1000x
4. Define the following microscopic terms:

• Slide
  • A slide is a small piece of rectangular glass upon which the specimen to be viewed is placed.

• Coverslip
  • The coverslip is a piece of glass the same shape as a slide (but often thinner) used to cover the specimen.
  • The specimen is sandwiched between the slide and the coverslip.

• Wetmount
  • Wetmounting is when the user smears a wet specimen onto a slide.
4. Define the following microscopic terms:

• Fixing
  • Fixing preserves a specimen so that it does not decompose. Once a specimen has been fixed, it can be stored away and looked at again later.

• Staining
  • Staining colorsthe specimen so that it has a higher contrast and can be more easily seen under the microscope.

• Oil immersion
  • In order to get a sharp focus at magnifications above 400X, light must be coupled between the specimen and the objective by a layer of oil. If the light travels through air it gets too distorted.
4. Define the following microscopic terms:

• **Unicellular**
  - A unicellular organism has only one cell.
  - Unicellular organisms include bacteria, protists, and yeast. For example, a paramecium is a slipper-shaped, unicellular organism found in pond water.
4. Define the following microscopic terms:

- **Multicellular**
  - A multicellular organism is made up of more than one cell.
  - Multicellular organisms are composed of more than one cell, with groups of cells differentiating to take on specialized functions.
  - nerve cells, skin cells, muscle cells, blood cells, and other types of cells
4. Define the following microscopic terms:

• Cilia
  • Cilia are small hair-like appendages around the edge of a cell which allows the cell to propel itself through water.

• Flagella
  • A flagella is a whip-like structure at the end of a cell that allows it to swim through the water.

• Plankton
  • Plankton are any type unicellular marine organism at the bottom of the food chain.
5. Activity

- Collect samples of water (from ponds, streams, ditches or puddles etc)
- Search for living organisms using a microscope
- Use at least 100x magnification
- Identify five organisms
- Draw five organisms and label them
- Expect to see algae, hydars, protozoa, bacteria & some arthropods too
6. Draw and label a cell
6. Plant cell vs Animal cell
The Six Kingdoms

When Linnaeus developed his system of classification, there were only two kingdoms, **Plants and Animals**. But the use of the microscope led to the discovery of new organisms and the identification of differences in cells. A two-kingdom system was no longer useful.

Today the system of classification includes six kingdoms.

The Six Kingdoms:
**Plants, Animals, Protists, Fungi, Archaeabacteria, Eubacteria**.

How are organisms placed into their kingdoms?
- Cell type, complex or simple
- Their ability to make food
- The number of cells in their body
Kingdoms of Microscopic Life

Plants
You are probably quite familiar with the members of this kingdom as it contains all the plants that you have come to know - flowering plants, mosses, and ferns. Plants are all multicellular and consist of complex cells.

In addition plants are autotrophs, organisms that make their own food.

With over 250,000 species, the plant kingdom is the second largest kingdom. Plant species range from the tiny green mosses to giant trees.

Without plants, life on Earth would not exist! Plants feed almost all the heterotrophs (organisms that eat other organisms) on Earth. Wow!
Is

Kingdom is the largest kingdom with known species.

All animals consist of many complex cells. They are also heterotrophs.

Members of the animal kingdom are found in the most diverse environments in the world.

Tiger - Kingdom: Animalia, Phylum, Class Mammalia, Order Carnivora, Family dae, Genus Pathera, Species tigris
**Archaebacteria**

In 1983, scientists took samples from a spot deep in the Pacific Ocean where hot gases and molten rock boiled into the ocean form the Earth’s interior. To their surprise they discovered unicellular (one cell) organisms in the samples. These organisms are today classified in the kingdom, *Archaebacteria*.

*Finding Archaebacteria:* The hot springs of Yellowstone National Park, USA, were among the first places Archaebacteria were discovered. The biologists pictured above are immersing microscope slides in the boiling pool onto which some archaebacteria might be captured for study.

**Archaebacteria are found in extreme environments such as hot boiling water and thermal vents under conditions with no oxygen or highly acid environments.**
Eubacteria

Like archaebacteria, **eubacteria** are complex and single celled. Most bacteria are in the **EUBACTERIA** kingdom. They are the kinds found everywhere and are the ones people are most familiar with.

Eubacteria are classified in their own kingdom because their chemical makeup is different. Most eubacteria are helpful, produce vitamins and food. However, these eubacteria pictured above, can give ...
Fungi
Mushrooms, mold and mildew are all examples of organisms in the kingdom *fungi*.

Most fungi are *multicellular* and consists of many complex cells.

**Fun Facts about Fungi**

Fungi are organisms that biologists once confused with plants, however, unlike plants, fungi cannot make their own food. Most obtain their food from parts of plants that are decaying in the soil.

Some fungi taste great and others can kill you!
**Protists**

Slime molds and algae are protists. Sometimes they are called the odds and ends kingdom because its members are so different from one another. **Protists** include all microscopic organisms that are *not* bacteria, *not* animals, *not* plants and *not* fungi.

Most **protists** are **unicellular**. You may be wondering why those protists are *not* classified in the Archaebacteria or Eubacteria kingdoms.

It is because, unlike bacteria, protists are complex cells.

*These delicate looking diatoms are classified in the protist kingdom.*
8. Uses of Microscopic Life

• Human food
  • Leavened bread and cheese would not be possible without microscopic fungi.

• Human health
  • Intestinal bacteria play crucial role in human health
  • Maintains immunity, homeostasis & protection against pathogens
  • Dysregulation of gut flora leads to host inflammatory & autoimmune conditions ex: Inflammatory Bowel Disease (IBD), Irritable Bowel Syndrome (IBS)
  • Many bacteria cause illness Ex: Streptococcus, Staphylococcus, Salmonella & Escherichia coli
Uses of Microscopic Life

• Viruses can cause disease, few examples:
  • Common flu
  • Hepatitis
  • MMR
  • Chickenpox
  • HIV-AIDS
• Parasites can cause infections too...
  • Malaria
Uses of Microscopic Life

• Medicine
  • **Penicillin** grown from common moulds (fungus) is a powerful antibiotic
  • Used to treat many bacterial infections
  • Vaccination is an effective way to protect us against certain infectious disease
    • A process of administering weakened or dead disease-causing microscopic lifeforms to a healthy person to build immunity against a targeted disease
    • Ex: Chicken pox vaccine, MMR, DPT, BCG, Pneumococcal, Men B, Men C, Flu vaccine etc
  • Yet to figure out COVID-19 vaccine
Uses of Microscopic Life

• Other Organisms

Lichens
  • Symbiotic association of fungus and a photosynthetic partner (Cyanobacteria)
  • Plant like but not plants
  • Come in many colours, sizes and forms
  • Occur in sea level to high alpine mountains
  • Grow rock, trees and in extreme environments
9. Health habits established as a result of harmful microscopic life

- **Hand-washing**
  - Frequent hand washing helps remove disease causing germs away from body
  - Wash your hands before eating
  - Wash hands after you using the toilet

- **Tooth-brushing**
  - Brushing your teeth checks bacteria in the mouth
  - Prevents cavities and gum disease
9. Health habits established as a result of harmful microscopic life

• Vaccinations
  • Help develop immunity to deadly diseases
  • Polio and smallpox were both eradicated
  • World's most pressing need is an effective vaccine against COVID-19 virus

• Clean clothing
  • Changing into clean clothing every day, particularly socks and underwear, can prevent ailments like athlete's foot & jock itch
Summary

• Learnt about different microscopes
• Parts of the microscope
• Calculate total magnification
• Different microscopic life around us
• Uses of microscopic life in health and disease
Question time?
References:

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