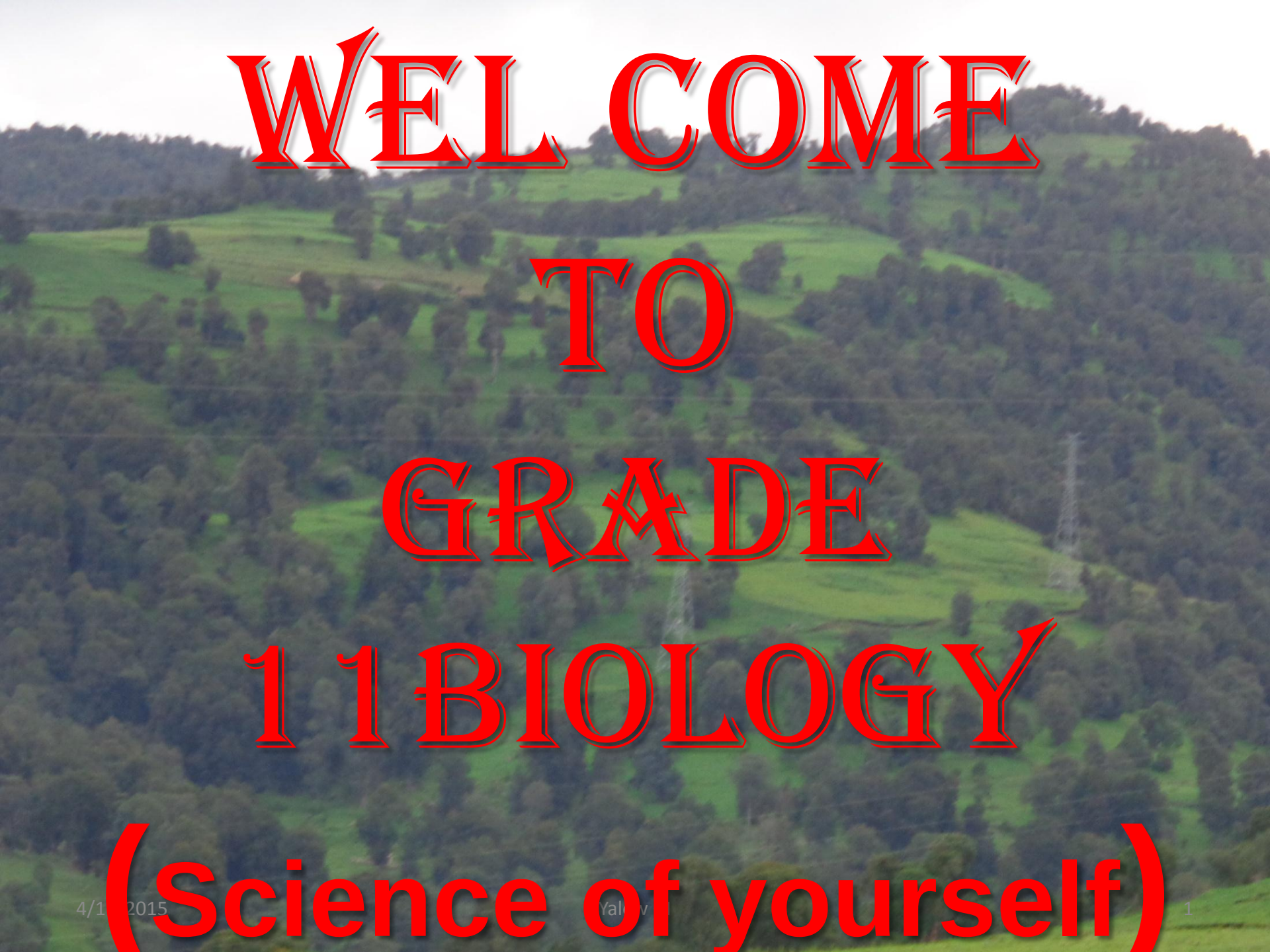




WEL COME

TO

GRADE

11 BIOLOGY

(Science of yourself)

UNIT 1

The Science of Biology

Biology:-the science of life and living organisms

➤ From two Greek words.

Bios - life

Logos- study

} the study of life

➤ So Biology—the Science of life and living organisms (Unicellular and Multicellular)

Q. What is to mean by:

A. Multicellular ?

B. Unicellular ?

Areas of biological Study

A. Astrobiologists

- ❑ Try to find evidence of life on other planets in our solar system and in galaxies else where in the universe .

B. Bio- medical research

- ❑ Development of new drugs and vaccines
- ❑ Also study the ways in which diseases develop to gain a better understanding of them so that cures can be found

C. Micro biology

- ❑ How microorganisms of all kinds function.

D. Paleobiology

- ❑ The way in which life began on earth and how it has evolved from simple life forms in to more complex ones.
- ❑ Use evidences from rocks fossils etc to estimate when and how new life forms appeared on the planet.

Beside these others may include

➤ Doctors

➤ Dentists

➤ Veterinary surgeons

➤ Physiologists

➤ Geneticist ,

➤ oncologists

➤ Neurobiologists

➤ parasitologists

➤ Entomologists

➤ Nurses

➤ Physiotherapist

➤ Botanist

➤ Zoologist

➤ Etiologists

What is science?

- The word science is derived from the Latin word – **Scientia** which is to mean knowledge.
- It is a unique system of acquiring knowledge based on scientific method.
- It is some times called experimental science because it depends on experimentation to obtain the information.

Science

Experimental science:-
the use of experiments to
obtain information.

Applied Science :- the use
of scientific research to
meet certain human needs



What is scientific method?

❖ Is the process by which Scientists approach their work

Main steps in scientific method

1. Observation and Asking question.
2. Do back ground research.
3. Construct the hypothesis.
4. Design and carry out an experiment to test the hypothesis.
5. Analyse result and draw conclusion.
6. Accept or reject hypophesis.
7. Report results.



Definitions

- **Control group** –the standard group in an experiment in which the experimental groups are compared with.
- **Experimental groups-** the group in an experiment which is being experimented on in order to compare with the control group.

Cause and effect

1. *Independent variables(IV)*

- The variable that the experimenter changes to see if this affects the performance of the dependent variables.

2. *Dependent variables(DV)*

- The factor in an experiment that the scientists measures to see if it changes when the independent variable is change

3. *Controlled variables*

- Factors other than the independent variables that are kept constant in order to avoid the influencing results

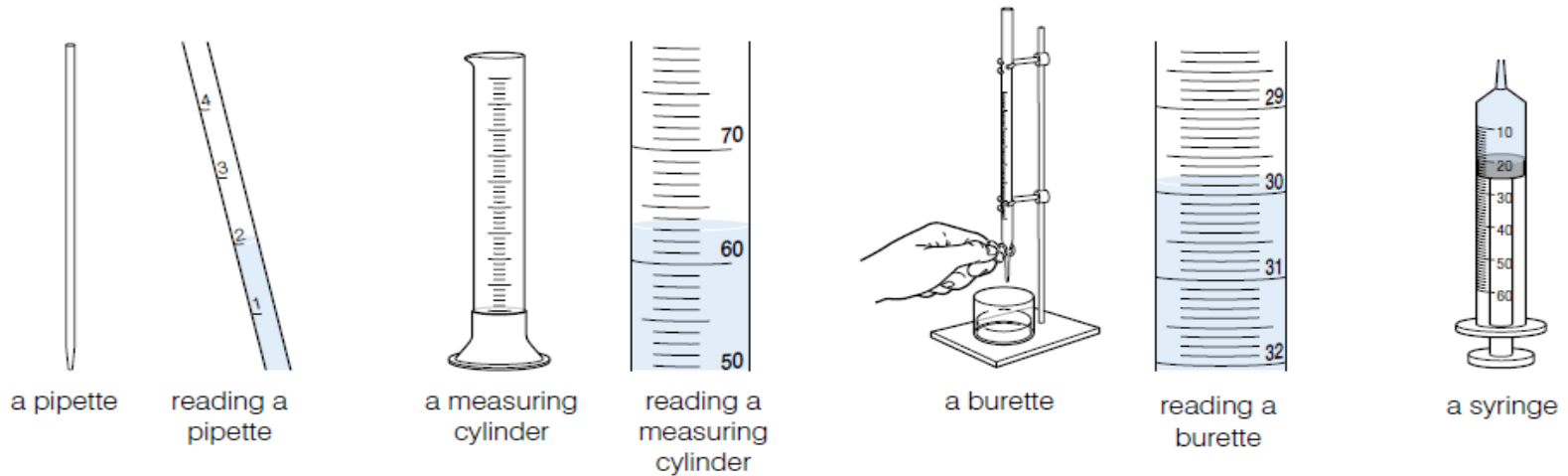
4. *Confounding variables*

- A factor that can not be controlled and which may influence the result of the experiment.

Accuracy, Reliability & Validity in scientific experiments

1. Accuracy

- ❖ How precisely something has been measured or counted.
- ❖ The level of accuracy must reflect the magnitude of what we are measuring.



2. Reliability

- ❖ Is the measure of how dependable and consistent the result of an experiment are.

- ✓ To increase the reliability of the experiment.
- 1. Standardize the procedure to do always the same thing.
- 2. Repeat it many times to:
 - i. Spot any anomalous result (odd result that do not fit)
 - ii. Calculate an average result
- 3. Not try to use personal judgment

Example

- We can use a special apparatus called a colorimeter which measures how much light passes through a liquid.
- It is nearly always better to measure than to judge.

3. **Validity**

- ✓ Whether or not our experiment measures what it says it is measuring.
- ✓ For our experiment to be valid, we must be certain that our results were only due to the changes in the independent variable and nothing else.
- ✓ So had we not controlled all the other variables, our experiment would not have been valid.

How do we write reports on scientific experiments?

There must be:

1. a title, which states clearly what is being investigated
2. a hypothesis, stated clearly in terms of how the independent variable is expected to influence the dependent variable, often extended to a prediction for the particular experiment
3. a clear description of the experimental procedure; this must be in such detail that anyone of the same level of understanding could easily replicate the procedure and it must include

- a) the apparatus used
 - b) details of any chemicals used; what volumes or concentrations or masses were used
 - c) details of any organisms used (for example, yeast, mice) - what strain and how many
 - d) details of any control experiments
4. a full account of the results obtained; it is often helpful to summarize these (where appropriate) in graphs, charts and tables

5. the conclusions that have been drawn from the results
6. an evaluation of the procedure; this is an honest assessment of the limitations of the procedure that has been used, pointing out any unavoidable limitations and inaccuracies that arose
7. an acknowledgement of the use of any other person's work; this is usually done by identifying by a number the place in the report where other work has been used, and then listing the sources at the end of the work.

1.2 The tools of a Biologist

What apparatus do biologists use?

What do biologists use in the laboratory?

➤ This is still a large list. But there are some basic tools. These include:

- a) microscopes
- b) dissecting equipment
- c) Petri dishes
- d) pipettes and syringes
- e) centrifuges
- f) measuring cylinders
- g) balances

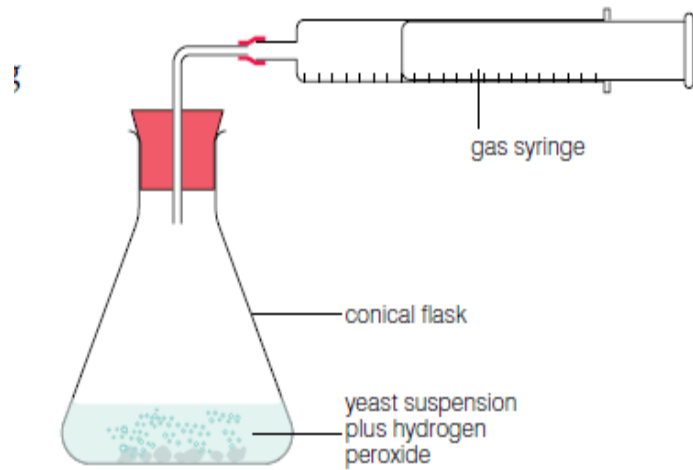


Figure 1.9 Using a gas syringe to measure the volume of oxygen produced when yeast decomposes hydrogen peroxide



A standard dissection kit



Dissecting a frog . . 6/2015

- Petri dishes are round dishes made from glass or from plastic.
- They are used in many different ways, but usually to culture some organisms.
- They are often filled with a 'jelly' called agar and used to culture bacteria. There are many different agars containing different balances of nutrients. Each type of agar can encourage the growth of different bacteria. By marking a grid on the surface of the Petri dish, biologists can estimate how much of the dish is covered by bacteria and then use this to estimate how fast the bacteria are growing.

➤ **Agar** jelly-like substance obtained from seaweed, used for culturing micro-organisms in a Petri dish to culture organisms means to grow them under special conditions that are likely to help their growth Petri dishes are also used to propagate or culture plants

Petri dishes can also be used to:

- a) show how effective different antibiotics are against certain types of bacteria
- b) show how well different concentrations of enzymes digest a substance



Plantlets or 'explants'

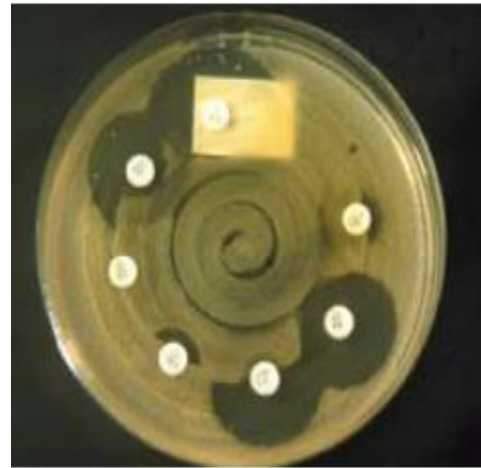


Figure 1.15 Bacteria being cultured on agar in a Petri dish with several different antibiotic discs



Figure 1.16 'Starch-agar' with four 'wells' cut in the agar; each well contains a different strength of enzyme solution

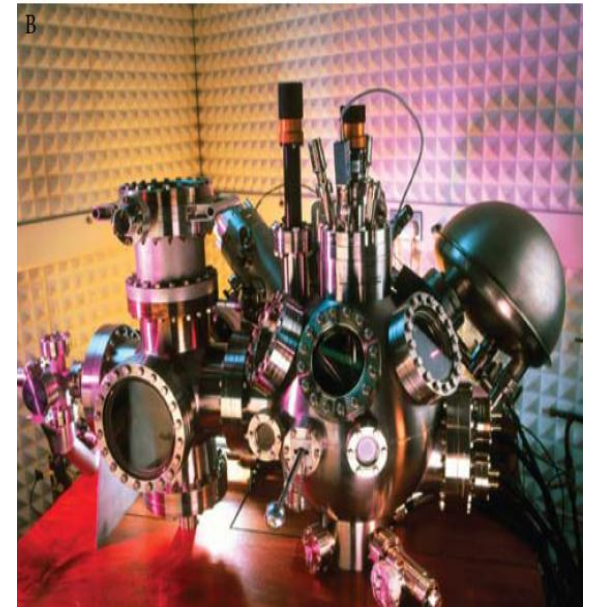
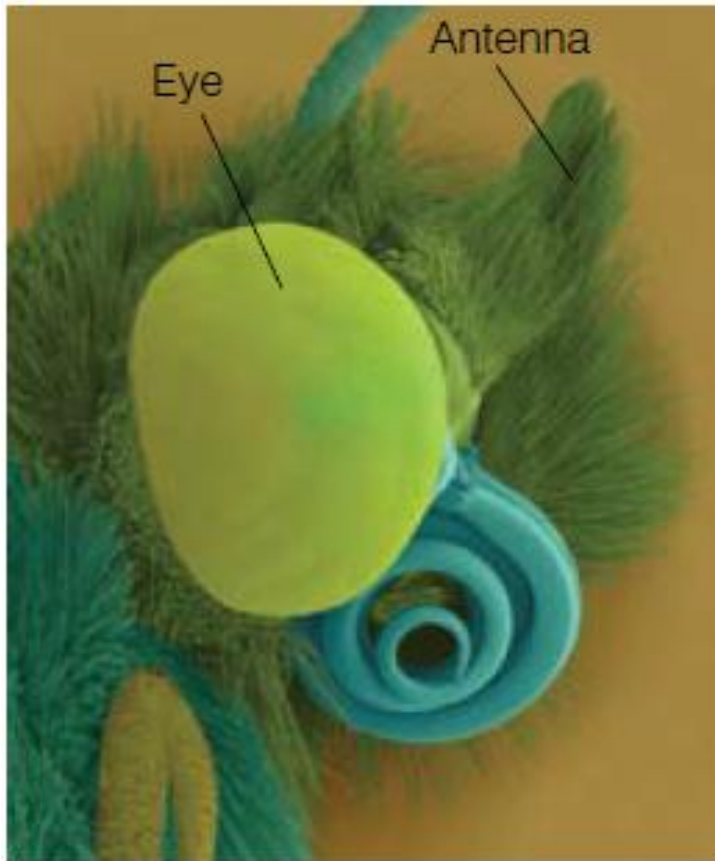


Figure 1.17 A A light microscope; B An electron microscope

- This technique of growing plants from just a few cells on special agars in Petri dishes is called **micropropagation**. It allows thousands of plants to be produced from just one 'parent' plant.
- All the plants produced are genetically identical.
- **optical microscopes** that use *beams of light* to produce magnified images.
- **electron microscopes** that use *beams of electrons* to produce magnified images
- **Transmission electron microscopes** - allow researchers to view the structure of cells in great detail.
- **Scanning electron microscopes** -create images of the surface of a specimen by scanning it with a high-energy beam of electrons.

A



B

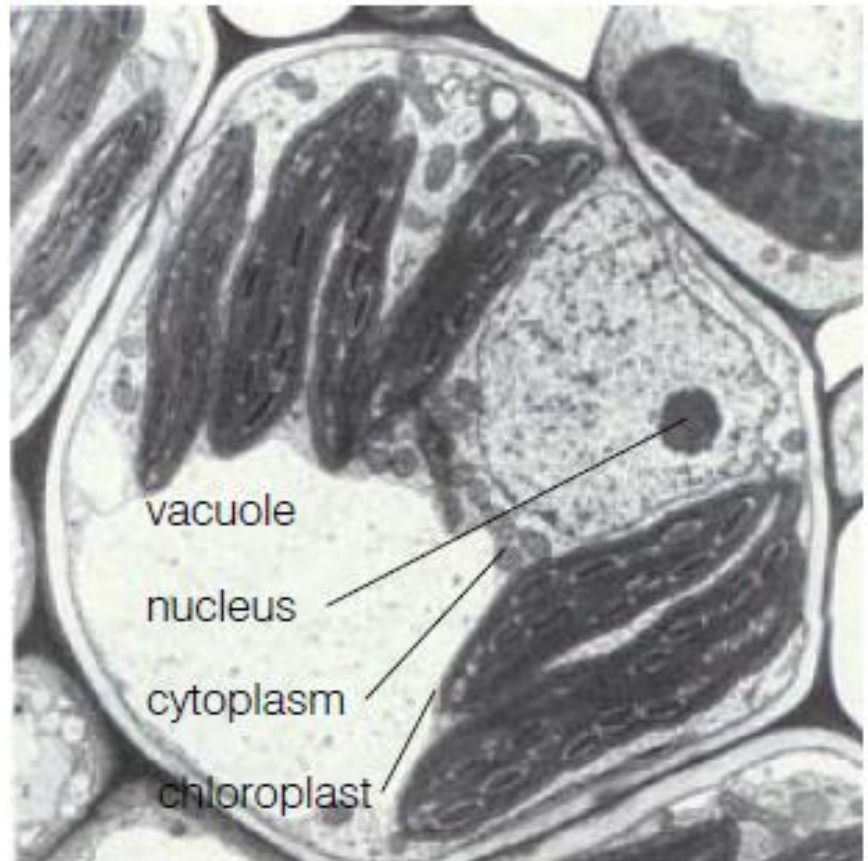


*Figure 1.18A SEM of the head of a monarch butterfly;
B TEM of a cell from the leaf of a tobacco plant*

What do biologists use in the field?

- Biologists do a lot of work outside the laboratory.
- They study different areas to find out how the animals, plants and micro-organisms interact with each other and with the environment.
- They find out how an area changes over time and how it is influenced by human activity.
- All this involves:
 - a. taking measurements of the abundance of organisms in the field
 - b. taking samples of the environment (for example, soil, rocks, water) for analysis in the laboratory

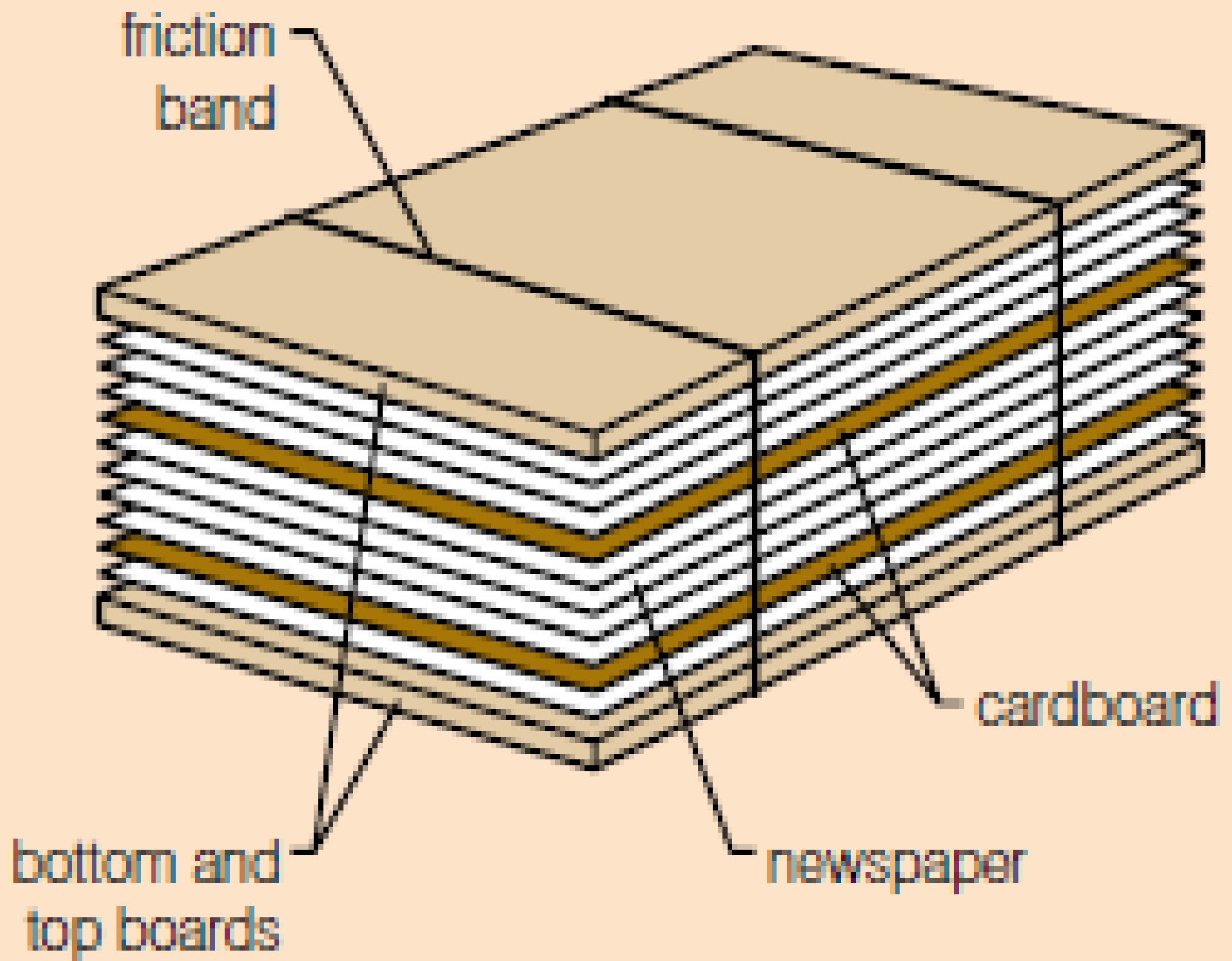
c. collecting specimens for identification and analysis in the laboratory

- To gain an estimate of the abundance of organisms in an area, biologists often use quadrats.
- There are many different types, but the simplest is just a metal square.
- It is placed randomly on the ground and the organisms found inside it are counted and the numbers and types recorded.
- This data can be used to make an estimate of the abundance of the organisms in the area.
- The use of quadrats is not confined to sites on land. They can be used underwater also!



- Biologists also use quadrats to show how the numbers of a particular species changes across an area. To do this, they lay down a tape measure (or a long rope marked off every metre) across the area.
- This is called a **transect line**.
- They then place the quadrat by the side of the transect line and record the abundance of the organisms in the quadrat.
- They repeat this every meter, or every 5 or 10 meters, depending on the length of the transect. This gives a picture of how the abundance of each species changes across the area.

- Parts of plants can be collected and kept in reasonable condition for a short period **in plastic jars or plastic bags**.
- Parts of plants can also be preserved using **a plant press**.
- This preserves the shape and form of the plant parts for some time and specimens can be analyzed later.
- Whole plants can be dug up and replanted for study in the laboratory.



A plant press

- However, animals pose a different problem. Because they move, they must be caught.
- Biologists do this in many different ways.
- Some insects can be caught using **nets** like the ones shown in figure below.
- Others are caught using **pitfall traps**.
- Pitfall traps come in a range of shapes and sizes.
- This simple one is just a plastic carton sunk into the soil.
- It would be covered with wood to keep it dark and dry and also keep any animals that fall into it out of sight of predators.



B. Pitfall traps

A. Students using nets to collect and study insects.



- One recent addition to the tool list of field biologists is the **GPS (Global Positioning System) receiver**.
- This equipment makes it possible to record positions quickly and extremely accurately.
- By taking several readings at different points on the perimeter of the area, an accurate map of the area can be drawn.



Figure 1.23
A data logger – this is used to record information



Figure 1.24
A pH kit – this is used to measure the pH of soil or water



Figure 1.26 A field microscope – this is used to investigate the structure of specimens in the field, whilst still fresh



Figure 1.27 A theodolite – this is used to measure the height of trees or of slopes in the area



Figure 1.25
A flow meter – this is used to measure the rate of flow of water



Figure 1.28 A GPS (Global Positioning System) receiver

1.3 The relevance and promise of biological science

A. Biology And Agriculture

- The world's population is growing at an alarming rate and this poses challenges to governments all over the world.
- The extra people all need homes, food and all the other services that are provided.
- Many biologists are addressing the problem of how to produce the extra food.
- However, they have another problem to consider, which is that *global warming* may alter the way in which crops grow.

➤ Many crops that now produce high yields in some countries will not do so if the current trends continue.

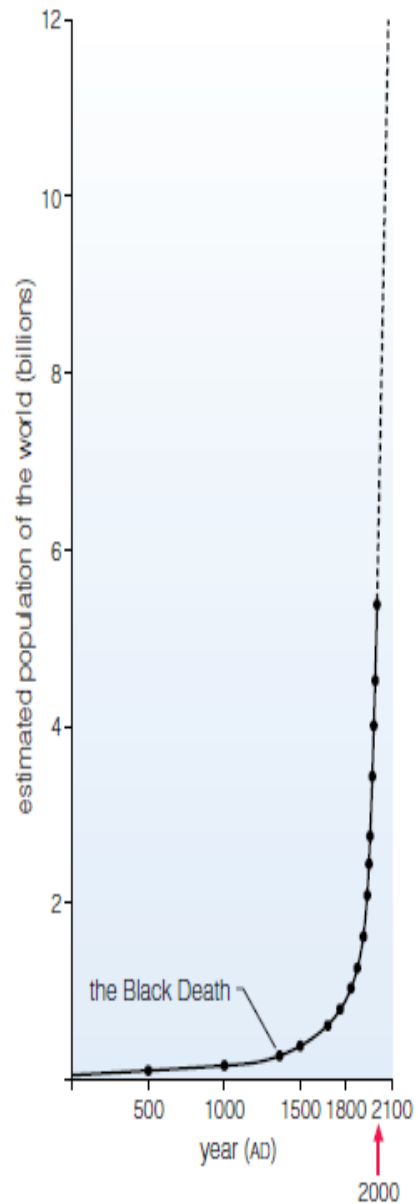


Figure 1.29 How the world population has changed over the past 2000 years

- Some countries will benefit, as they will find that their agricultural output will increase with **global warming**.
- Biologists are carrying out research into how to produce crop plants that:
 - a) will be adapted to the new conditions
 - b) are capable of producing their crop quickly so that more than one crop can be obtained per year from a field.
 - c) are disease resistant
 - d) are drought resistant
- This work involves the **genetic modification** of existing crop plants to give them the new characteristics that will enable them to be productive in the changed environment.

Biology and medicine

- Biologists are also able to give advice on ways of reducing the rate of population growth.
- They can advise individuals and governments on effective methods of **contraception** and ways of **educating people** about the need to **limit population growth**.
- Biologists, as we found earlier, are closely involved in medical work.
- Doctors and nurses have specialised biological knowledge and expertise to help sick people and to advise people on ways of staying healthy.

- Their work is supported by a whole range of other biologists, such as:
- a) **medical laboratory technicians** who test blood samples and other samples and provide reports for doctors
 - b) **medical researchers** who are constantly finding out more about the ways in which disease-causing organisms function and are spread
 - c) **radiographers**, who produce X-rays and other images to help in the diagnosis of disease

- d) specialised researchers who look into why and how cancer is caused
 - e) drug development researchers, who usually work for a commercial company and develop new drugs to treat diseases
- ☐ These are just a few of the biologists involved in medical work - there are many others.

Biology and the environment

- **Biotechnology** *is the use of micro-organisms and enzymes that will benefit mankind*
- Biologists are actively involved in monitoring the impact of global warming on the environment.
- These biologists give advice to governments on how best to conserve environments and to, where necessary, introduce new species that will maintain the best balance of species within the area.
- **Biotechnology** *is an exciting area of biological research that is expanding rapidly.*
- It involves many different aspects of biology.

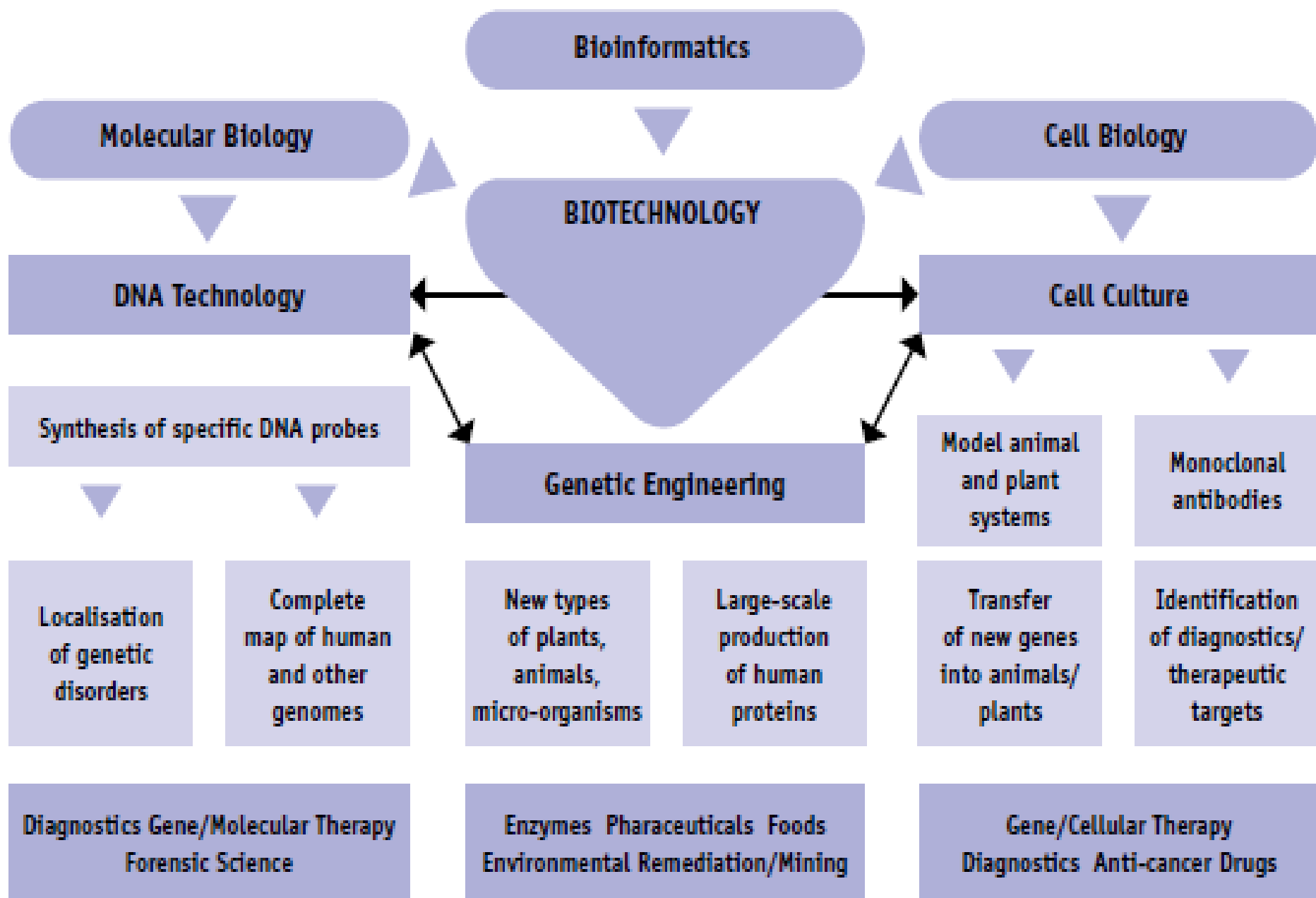


Figure 1.30: A flowchart showing different branches of biotechnology

❑ The promise of research in these fields is huge. Among the goals are:

- a) cures for genetic diseases
- b) treatments for degenerative diseases, such as *Parkinson's* disease and *Alzheimer's* disease.
- c) establishing biologically controlled industrial processes to manufacture more biological products in the same way as insulin is now manufactured.
- d) producing drugs that are '*tailor-made*' to suit an individual's needs.

e)genetically modifying plants to meet a specific need; for example:

- plants that can produce a good yield of a crop in dry conditions
- plants that produce their own insecticide will not need to be sprayed with chemical insecticides

f)cloning of productive animals and plants

g)production of monoclonal antibodies that can deliver a drug to only those cells that need treatment (for example, cancer cells)

h)using stem cells to repair damaged organs and, ultimately, to grow whole new organs from just a few of a person's stem cells

Biotechnology

Biotechnology isn't just new technology. Some biotechnological applications have been around for thousands of years. Using yeast to ferment sugars has been used for centuries in the manufacture of both bread and alcoholic drinks.

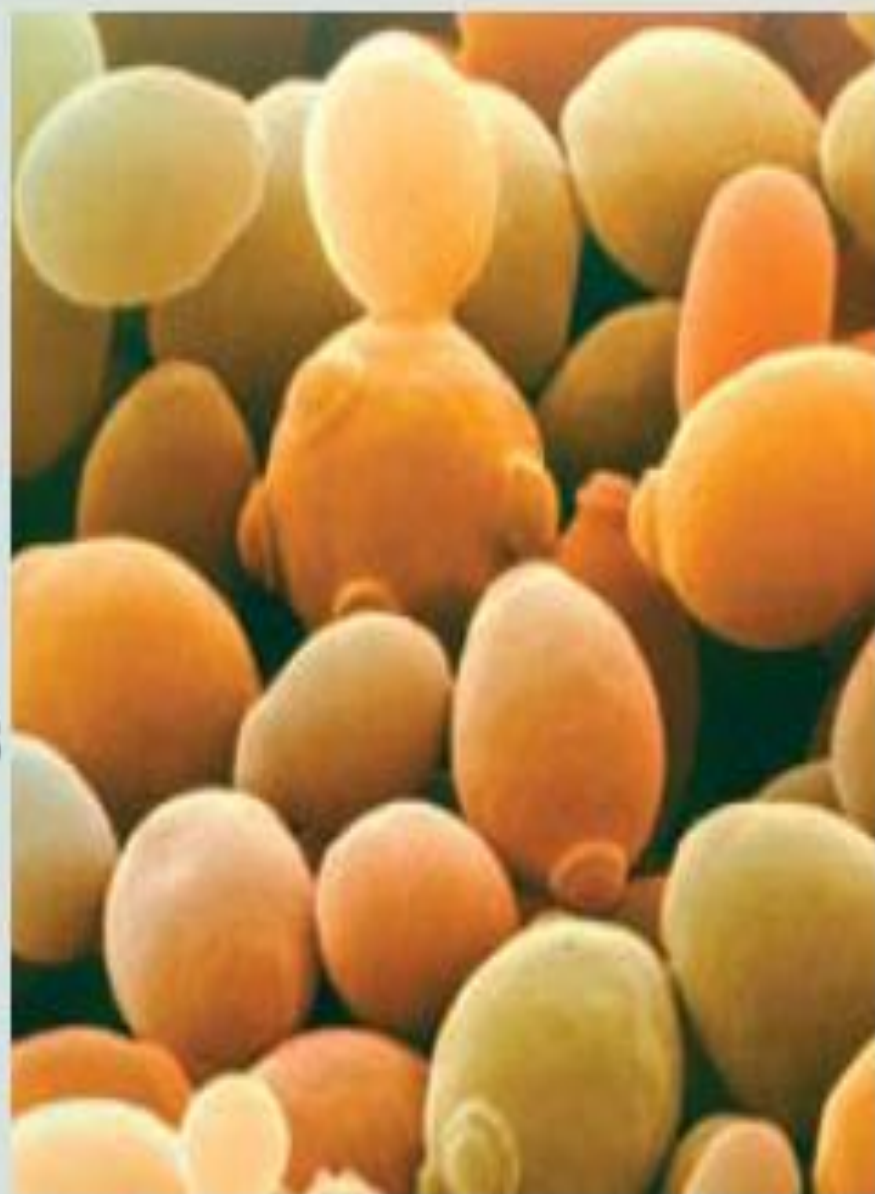


Figure 1.31 Yeast is a unicellular fungus that can ferment sugar to produce alcohol and carbon dioxide.

The relevance of biology in Ethiopia

- Biology is very relevant in Ethiopia considering the issues of overpopulation, food security, environmental well-being, health care, natural resource conservation, biodiversity and others, which the country needs to address.
- Practical biological knowledge is of special relevance for Ethiopia and education in biology needs special attention.
- ✓ As citizens of Ethiopia we must have the biological literacy to understand and assist in the preservation, development and proper use of the abundant biological resources which are our heritage.

- ✓ We need to systematically combine the wealth of indigenous knowledge with modern science by training an army of able biologists.
- ✓ We need to control land degradation, biodiversity loss, diseases and other problems, as well as to develop the biological and agricultural potential that will contribute positively to transforming our country's economy.

1.4 Biology and HIV/AIDS

➤ AIDS is short for

A= acquired

I= immune

D=deficiency

S=syndrome



➤ and is caused by the human immuno deficiency virus (HIV).

H= human

I= immuno deficiency

V= virus

- AIDS is short for acquired immune deficiency syndrome and is caused by the human immuno deficiency virus (HIV).
- HIV infects cells in our immune systems called T-helper cells that enable us to fight off other diseases.
- For a time, our body keeps replacing the HIV-infected cells, and this can last for many years.
- However, the body eventually cannot keep pace and AIDS develops.
- People suffer from ‘opportunistic’ infections that they would normally have been able to fight off.

- They also start to develop some forms of cancer that they would not normally develop.
- AIDS is usually fatal. The AIDS *epidemic* is affecting more people than ever before.

There are:

1. 33 million people living with AIDS (2.2 million in Ethiopia)
2. 2 million children living with AIDS
3. 11.6 million AIDS orphans in Africa alone (650 000 in Ethiopia)
4. over 17 million women living with AIDS worldwide

➤ AIDS is largely a sexually transmitted disease (STD), although there are four main ways in which HIV can be transmitted. These are:

- I. *homosexual* or *heterosexual* intercourse with an infected person
 - II. *transfusion* of *infected blood* or *blood products*
 - III. *sharing infected needles*
 - IV. from *mother to child* during pregnancy(MTC)
- In all these cases HIV must cross a barrier and find its way in to the blood so that it can infect the T-helper cells and multiply.

How can biology help in the fight against AIDS?

- There are several methods of combating the spread of a disease.
 - A. Break the transmission pathway - if the disease cannot spread from one person to another, it will eventually disappear
 - B. Produce drugs that kill the virus or at least stop it from reproducing.
 - C. Produce a vaccine against the virus. When vaccines are used, one of the aims is to build up a 'herd immunity' to break the transmission pathway. If enough people in an area are immune, the micro-organism causing the disease cannot easily spread to an uninfected person and so the disease is **eliminated**

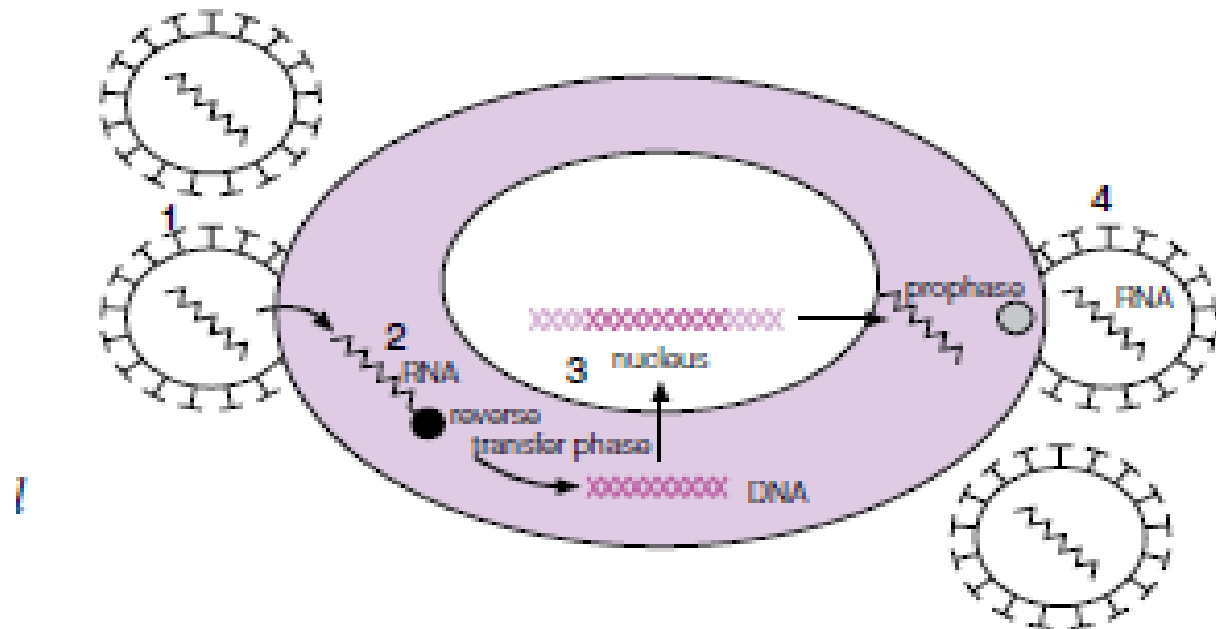
➤ HIV and similar viruses are called retroviruses and they all have a similar life cycle,

1 - the entry phase

2 - viral genetic material is converted to DNA

3 - the new DNA enters the host cell DNA

4 - the new DNA 'instructs' the cell to make more HIV.



- Biologists have developed drugs that target and aim to break this life cycle. They are called anti-retroviral drugs.
- There are different anti-retroviral drugs that target different stages in the life cycle.
- They are more effective when taken in combination than when taken singly, although there can be side effects.
- The combination treatment is called *highly active anti-retroviral* therapy, or **HAART**.
- However, it is important to remember that these drugs only treat the HIV that is currently present in the body.

- They do not provide any lasting immunity and a person could be reinfected.
- A vaccine would provide lasting immunity against reinfection by HIV.
- One of the problems has been that HIV mutates (changes) rapidly and that any one infected person can have several different types of HIV in them.
- However, researchers have found a part of the virus that is found in all strains of HIV and is crucial to the virus infecting the cells.

- Also, other biologists are studying a group of people in Kenya who have been repeatedly exposed to HIV but never developed AIDS. Their immune responses to HIV may hold the key to a vaccine.
- It has been shown that human antibodies produced against HIV completely protect some monkeys against a very similar disease caused by a very similar virus.
- A vaccine could well be possible.

What can we do in the fight against AIDS?

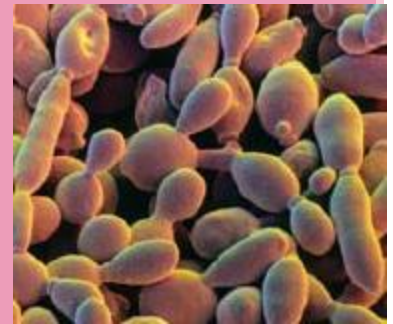
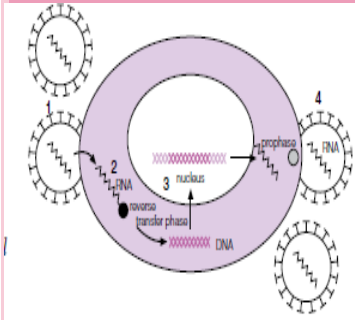
- There are a number of things that all of us can do. The first is to recognise that people with AIDS are quite simply sick people who need medical care as well as the support and love of their families and friends.
- AIDS victims have been stigmatised for years in all countries all over the world.
- This makes the problem worse in a number of ways:



- a. It makes it harder for victims to come to terms with their illness.
 - b. It may prevent them from seeking early advice for fear of stigmatization; this in turn may lead to further infection before the condition is diagnosed.
 - c. It can make governments reluctant to take decisive action for fear of offending powerful pressure groups.
- We can do little about the transmission of AIDS through infected blood products or from mother to child, there are things we can do to help control the spread of AIDS by breaking the transmission pathway.

These include:

- I. *Restricting the number of sexual partners.* In terms of AIDS, this is simple mathematics. If we have sex with many people, we increase our risk of contracting HIV and then passing it on. Sex within a loving, monogamous relationship limits the spread of AIDS.
- II. *Men can elect to be circumcised.* This significantly reduces the risk of men acquiring HIV, although it has little effect on them passing on the virus if they do become infected.
- III. *Not sharing infected needles*
 - Remember, community action is always better than individual action.



End of Unit 1

