

CHAPTER 8

Micro - Organisms around Us

Micro-organisms are tiny organisms which cannot be seen with our naked eyes but with microscopes. Anthon Van Leeuwenhock (1632-1733) was the first person to discover them with his microscope. These micro-organisms are found everywhere such as in the air, dust, soil, water, food, inside and on plants, on our clothes, on our bodies and inside our bodies. Many of them are beneficial, harmless or non-pathogenic, while some of them cause diseases and are said to be pathogenic and hence, harmful.

Groups of Micro-organisms

Micro-organisms may be put into the following groups: bacteria, virus, some algae, protozoa and some fungi. They vary in size, shape, structure and functions.

Viruses are so tiny that they can only be seen through the electron microscope. They can be rodlike, spherical or ovoid in shape. Each consists of a strand of nuclear protein. They can only reproduce inside a living cell such as a fertilized egg cell. They are often host specific.

They are predominantly parasitic and are known to cause many diseases such as mumps, measles, influenza, rabies, poliomyelitis, colds, tobacco mosaic disease and recently, AIDS.

Bacteria are micro-organisms that can be seen with a light microscope. An electron microscope however, will reveal their structures best.

They occur in large numbers and are found everywhere. They grow in colonies i.e. thousands of bacteria massed together.

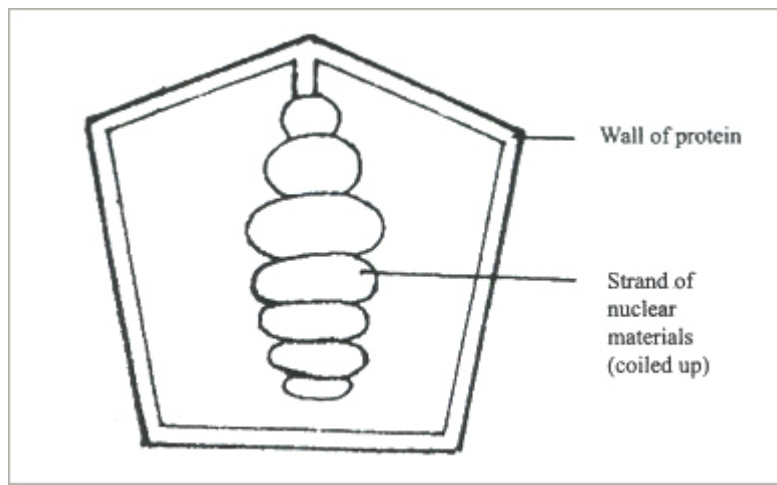


Fig 8.1 A virus

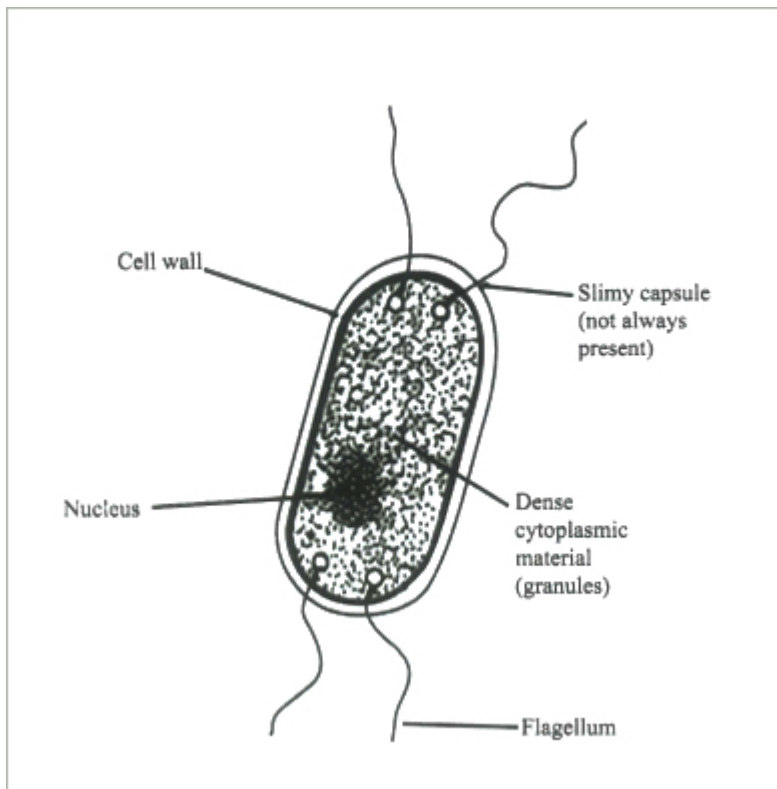


Fig 8.2 Bacterium

A typical bacterium is about one thousandth of a millimetre in width. It consists of a cell that may or may not be covered with a slimy capsule, a cell wall, a cell membrane, dense cytoplasmic granules and no proper nucleus but a nuclear material (i.e. Deoxyribo nucleic Acid – DNA) which is spread through the cell.

Bacteria can be described on the basis of their use of oxygen for respiration. Those that need oxygen are called *aerobic bacteria*. Others which do not need oxygen for their respiration are called *anaerobic bacteria* e.g. putrefying bacteria. Most bacteria that can live under aerobic or anaerobic conditions are called *facultative bacteria*.

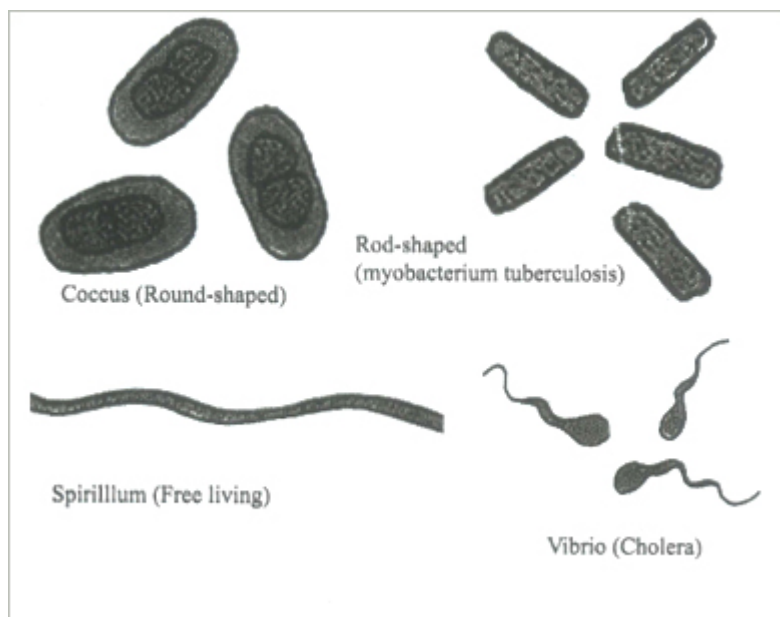


Fig 8.3 Types of bacteria

Bacteria occur in different sizes, and shapes and are named according to their shape as shown in [Fig. 8.3](#).

- (a) The circular ones are called cocci e.g. streptococci bacteria. They stick together to form a chain e.g. sore throat bacteria. Staphylococci - These bacteria bunch together e.g. Boil bacteria. Diplococci -These stick together in pairs e.g. those that cause pneumonia (*Pneumococcus*).
- (b) Bacilli bacteria - They are rodlike in shape e.g. those that cause anthrax and typhoid fever. Some have flagella which aid them in locomotion.
- (c) *Vibrio* (bent rod) — These bacteria are curved and comma shaped e.g. cholera bacteria.
- (d) *Spirillum* - They are spiral, twisted types. Some are mobile, the spirochaetes, for example those that cause syphilis.

Fungi

These are non-green. Fungi are not plants. They occur as parasites or saprophytes. The saprophytic fungi are beneficial to human beings. The parasitic ones are harmful because they cause various diseases.

Protozoa

They are microscopic, unicellular organisms. Some of them are free living e.g. *Amoeba* and *Paramecium*. Others are parasitic e.g. trypanosomes, *Plasmodium*. The latter are often carried by vectors.

Concept of Culturing

Culturing involves making a sterile medium, inoculating, incubating and examining micro-organisms. Through it, their characteristics such as colour, pattern of growth and appearance can be studied. Cultures of micro-organisms can be grown from air, water, animals, plants and

from various parts of the human body.

You may be provided with sterilized petri dishes with culture medium added. You will learn how to grow the micro-organisms, observe, record and discuss your observation. Making a culture medium is a bit technical and it may be dangerous too if those involved in the exercise are not careful. It is advisable that the teacher prepares the culture medium ready for the use of students.

Culture Solution Preparation

Certain precautions must be taken while culture solutions are being prepared. These are:

- â€¢ The hands should be washed with soap before and after the agar preparation.
- â€¢ Open the petri dishes only slightly and cover at once.
- â€¢ Secure firmly with adhesive tape.
- â€¢ Avoid coughing, sneezing and touching infected jelly.
- â€¢ The sick must not be allowed to participate in culturing experiments.
- â€¢ Disused agar should be sterilized by washing in strong soap and disinfectant e.g. 40% formol-dehyde. They can also be heat-sterilized.

Please note that agar is prepared under sterile conditions using the procedure stated below:

1. Boil and pour it into sterile petri dishes.
2. Allow it to cool and set in the petri dishes.
3. A heat sterilizer or autoclave may be used to kill off micro-organisms in the petri dishes.
4. Introduce the material into the agar medium and cover immediately.
5. Place the petri-dish in a warm and dark compartment or an incubator.
6. Observe and record for 2 or 3 days.

Identification of micro-organisms

Micro-organisms can be identified in the air, pond water, river, stream, on the teeth, in expired air, in dirt under the nail and on other various carriers. In order to do this effectively in the class, the teacher should divide the students into manageable working groups. Also, each group should be provided with sterilized petri dishes containing a culture medium.

The following steps can be taken in order to identify micro-organisms from various sources.

1. Label 5 covered petri dishes with culture media - A, B, C, D and E respectively.
2. Put in A a few drops of pond water.

3. Put in B a few drops of river water.
4. Put in C a few drops of stream water.
5. Expose D to air for about ten minutes and then cover it.
6. Let E serve as control. Do not introduce anything into it.
7. Leave all the petri dishes in the laboratory for three days.
8. Observe the petri dishes for any development. Note any differences in each of the petri dishes.
9. Record the characteristic colours and the type of colonies developed in each petri dish.
10. Class discussions can follow the recorded observations.

Micro-organisms on our bodies and food

It has been found by microbiologists and some other groups of scientists that micro-organisms are present on and in various parts of our bodies. These parts include our hair, skin, nose, ears, mouths, teeth and under the nails; in other words, wherever dirt can thrive or be hidden.

To demonstrate this, you will need to carry out an experiment under the supervision of your teacher. You will be guided in identifying micro-organisms present in the mouth, expired air, and under the nails. Petri dishes with culture media as in the last exercise will be needed. The following procedure is to be followed.

1. Let petri dish A serve as control by not exposing it at all.
2. Let B be inoculated with food debris from the teeth or corner of the mouth.
3. Let C be exposed to expired air when someone breathes out.
4. Let D be inoculated with scappings from a dirty nail.
5. On each occasion, the petri dish should be opened slightly before introducing a material meant for culturing.
6. Close the petri dish quickly.
7. Leave the material in a safe place in the room or laboratory.
8. Let all the petri dishes be kept undisturbed for three days.
9. Observe colour, areas covered, and type of growth in each petri dish.
10. Record all the observations.

Class discussions should follow this

Micro-organisms in our food

All foods can harbour micro-organisms. The microbes thrive where there is a wound or dirt. Presence of microbes can be ascertained in foods such as fruits and vegetables. Many plant diseases are caused by microbes. Pawpaw, oranges, tomatoes, yam, vegetables, e.t.c. become rotten as a result of the activities of micro-organisms.

To demonstrate this, small pieces of bread or any of the food materials named above may be put in separate watch-glasses. They should be left for about three days. Observe and record any development. The commonest microbes which are found developing on

our food items are bacteria and fungi. They may render the food materials messy, smelly and unfit for consumption.

The micro-organisms enter the human body through the mouth into the gut, via the food we eat and the water we drink. They also enter through the nose with the air we breathe into the respiratory system e.g. cold-causing virus. They also enter through the skin via wounds (e.g. tetanus) into the muscles and blood stream or directly through the skin surface e.g. fungal infection leading to ringworm of the head and foot. See [Table 8.4](#).

Some diseases are spread from one person to another by personal contact. The commonest examples are the sexually-transmitted diseases e.g. gonorrhoea, syphilis and AIDS.

Modes of transmission of germs

Germs are carried by air, water, food and vectors as well as personal contact.

Droplets e.g. cold, cough – This is a method by which millions of germs from a diseased individual are released into the environment. The individual may yawn with the mouth wide open, sneeze, snore or spit. Each way, droplets are sprayed onto others around. The victims may directly inhale the germs contained in the droplets. Sometimes the germs may wait and dry up. Spores of the bacteria and viruses are then reintroduced into the air. See [Table 8.1](#).

Insect carriers – Some insects e.g. female *Anopheles* mosquito and tsetse fly are carriers of malaria parasite and sleeping sickness parasite respectively. They bite and pierce the skin of their victims. In the process, they inject their victims with germs See [Table 8.3](#).

Drinking water – If a man drinks contaminated water, he may inadvertently be taking in germs of cholera, dysentery and diarrhoea. The same things go for contaminated food. See [Table 8.2](#).

Carriers of micro-organisms

Micro-organisms are carried by certain other living things, mainly insects, such as fleas and louse. (See [Table 8.3](#)). These are called *Vectors*.

- (a) Insect carriers: Housefly carries bacteria which cause bacillic dysentery, diarrhoea and cholera.
- (b) Mosquitoes – Female *Anopheles* mosquito carries malaria fever parasite (*Plasmodium*), which is a protozoan. Female *Aedes* transmits yellow fever and dengue fever which are caused by viruses.
- (c) Tsetse fly carries the sleeping sickness parasite (*Trypanosome*).
- (d) Rat flea, body louse and tick carry rickettsia, which is the parasite of typhus.
- (e) Rat flea carries a bacterium that causes plague.

The effects of diseases transmitted by these carriers on man are numerous and devastating. They lead to fever, discomfort, weakness of

the body and even death in some cases.

The carriers use various parts of their bodies to transmit micro-organisms. Any portion of their bodies that can make contact with a person can collect and spread the germs. The commonest parts are the legs, wings, ventral surface as well as the mouth parts.

Growth of micro-organisms

Micro-organisms e.g. bacteria and fungi are living things. They can feed, respire, reproduce and grow. Their growth is observable by the form of increase in number of their cells. Each bacterium, for example, divides into two every 20 minutes. The increase in the size of the colony is an index of the growth of microbes. Growth occurs under favourable conditions of sufficient food, adequate temperature, and humidity. Micro-organisms grow at different rates under various environmental conditions. The better the environmental conditions, the greater the growth rate of the micro-organisms.

Effects of micro-organisms

Micro-organisms may be grouped into two, according to their effects on man, plants and other animals. They may be regarded as beneficial or harmful.

Beneficial effects

Micro-organisms, mainly bacteria and fungi, are useful in various ways including the following:

1. In nature: Some fungi e.g. puffballs and some species of mushrooms are edible to man.
2. Many saprophytic bacteria are helpful to man in his agricultural practices. For instance, putrefying bacteria which are soil bacteria, decompose dead plants and animals. They reduce the organic matter into useful mineral salts such as nitrates, sulphates, carbonates, water and ammonium salts. They produce humus in the process. All the nutrients enrich the soil and the plants or crops benefit by improving their production.
3. *Sewage* is also decomposed into harmless substances by bacteria.
4. Nitrogen-fixing bacteria (*Nitrobacter*) and *Rhizobium* are soil bacteria, which are found in root nodules of legumes. They convert atmospheric nitrogen to soil nitrogen which is readily available to such plants (groundnut, mucuna and beans).
5. Nitrifying bacteria e.g. *Nitrosomonas* convert ammonia to useful nitrites. *Nitrobacter* converts the nitrites to nitrates.
6. Denitrifying bacteria convert soil nitrogen to atmospheric nitrogen.
7. Some bacteria produce enzymes which help to digest cellulose especially in ruminants, e.g. goat, cow.
8. Some bacteria which are found in man's large intestine assist in the synthesis of vitamin K and vitamin B complex.

Medicinal uses

Many useful drugs, mainly antibiotics, in form of syrup, capsules and injections have been formulated from a number of bacteria and fungi. Examples are Penicillin, a potent antibiotic, is obtained from *Penicillium notatum*. Streptomycin, is from *Streptomyces*. Aureomycin, is from *Aureomyces*. Others are tetracycline and chlormycetin. These antibiotics have been found to be useful in curing such diseases as tetanus, tuberculosis, typhoid and diphtheria. Certain vitamins, especially vitamin B, and some enzymes are obtainable from yeast (which is a fungus).

Industrial uses

Micro-organisms, bacteria and fungi in particular, are used in various ways in industries. Yeast is very essential in the baking industry. It causes dough to rise. It is also useful in brewing industries e.g. fermentation of sugar to alcohol – it is aided by bacteria. Lactic acid bacteria are used in curdling milk. Acetic acid bacteria (*Acetobacter*) are utilized in the production of vinegar from fruit juices and wine. Bacteria action is utilized in the retting of jute to obtain sacking or linen fibres from flax plants. Bacteria are used in the production of cheese, butter and yoghurt. The action of bacteria can make meat tender, ferment tea leaves, cure or ripen tobacco leaves as well as convert hide into leather during the tanning process.

Harmful effects of some microbes

The harmful microbes cause various diseases in man, plants and animals. They produce toxins which poison man and causes a lot of discomfort. The harmful microbes include mainly viruses, parasitic bacteria, fungi and protozoa.

Viruses are responsible for some debilitating diseases in man. These include rabies virus (which attacks brain cells), poliomyelitis virus (which attacks the nerve cells of the skeletal muscles), and yellow fever virus which attacks the liver cells. Others are smallpox, influenza and measles.

Bacteria cause certain diseases in man. Examples of such diseases include tetanus, diphtheria, tuberculosis, dysentery and cholera.

Fungi cause some human allergies and some superficial skin diseases e.g. ringworm and athlete's foot.

A few parasitic protozoans are responsible for some diseases in man. Examples are malaria fever by *Plasmodium* (malaria fever parasite) and *Trypanosome* (sleeping sickness parasite).

Table 8.1 – Airborne diseases

	Disease	Causative Micro-organisms	Mode of transmission	Host	Main symptoms
1.	Tuberculosis	Bacteria (<i>Mycobacterium tuberculosis</i>), (Tubercle bacillus)	Air	All ages of cows and man	Persistent dry cough, night sweats. Disease of lung is commonest
2.	Pneumonia	<i>Pneumococcus</i>	Air	Man, pigs, cows and birds	Respiratory tract infection which causes fever and leads to rapid respiration, pain in chest and shivering
3.	Diphtheria	<i>Corynebacterium diphtheriae</i>	Air water	Man	Pain in limbs
4.	Meningitis (cerebrospinal fever)	<i>Meningococcus</i>	Air	Young adults, Children	It invades brain coverings (meninges). High fever, serious headache, vomiting, stiffness of the neck.
5.	Leprosy	<i>Mycobacterium leprae</i>	Air (slightly by personal contact)	Young adults	It attacks nerve fibres which lead to loss of fingers and toes, causing terrible sores.
6.	Common colds	Virus	Air	Man-all ages	Running nose, fever, headache
7.	Influenza	Virus	Air	Man-all ages	General pains, fever, shivering, headache, sore throat and backache.
8.	Measles	Virus	Air	Children	General pains, sharp cough. Rashes appear in mouth, then face and the body.
9.	German measles (Rubella)	Virus	Air	Man-all ages	Dangerous for pregnant women (who may bear babies with deafness and malformed hearts). Rashes on face, glands on neck become swollen.

Plant diseases

Viruses are transmitted to plants via some insects, and air current. They cause leaf mosaic disease in tobacco, potato and tomato, and swollen shoot disease of cocoa plants.

Table 8.2 - Water-borne diseases

	Disease	Causative organism	Mode of transmission	Host	Main symptoms
1.	Cholera	Bacterium (vibrio cholerae)	Drinking water	Man	Very profuse diarrhoea (rice-water) with vomiting. A lot of water from body fluids which may lead to death.
2.	Typhoid and para-typhoid	Bacterium <i>Salmonella typhi</i> and <i>S. para-typhi</i> .	Water and food	Man	Fever (high temperature) and muscular pains, constipation or diarrhoea which could lead to death.
3.	Amoebic dysentery	Protozoan <i>Entamoeba histolytica</i>	Unhygienic or uncooked food	Man-all ages	Nausea, heavy vomiting and diarrhoea. Loss of blood, fever. May be fatal.
4.	Bacillic dysentery	Bacterium (carried by flies)	Water	Man	High temperature and diarrhoea.
5.	Polio-myelitis (infantile paralysis)	Bacteria	Food or Water	Children	Minor illness. Serious cases progress to the nervous system, producing meningitis and attacks on muscle nerves. Affected muscles cannot act, causing paralysis.
6.	Food poisoning	Bacteria	Bread and pastry	Man-all ages	Serious abdominal pain. Vomiting and restlessness.
7.	Infective hepatitis	Virus	Water	Man-all ages	Malfunctioning of the liver, loss of appetite, nausea and jaundice.

Table 8.3 - Diseases spread by vectors

	Disease	Causative organisms	Mode of transmission	Host	Main symptoms
1.	Malaria	<i>Plasmodium spp</i> (Protozoan)	Female <i>Anopheles</i> mosquito bite	Man	Shivering and sweating. High fever which may be continuous, irregular or occur twice a day.
2.	Dengue fever	Virus	Female <i>Aedes</i> mosquito bite	Man and monkey	High fever which subsides but re-occurs with a typical rash, severe pains in the joints back and head. Nausea, vomiting.
3.	Yellow fever	Virus	Bite from <i>Aedes</i> mosquito	Man	Fever, headache and backache. Temperature falls and the virus enters the liver and kidneys; jaundice develops.
4.	Sleeping sickness (Trypanosomiasis)	<i>Trypanosomes</i> (protozoan)	Tsetse fly bite	Man	Sleepiness, fever and headache. Muscular spasms. Painless lump develops at site of bite. Enlargement of spleen and liver.
5.	Louse typhus	Body louse	Rickettsia	Man	Typhus, fever, sudden splitting, headache, pains in muscles.
6.	Plague	Rat flea	Bacterium	Man	Shivering, fever, cough, difficult breathing.
7.	Botulism (food poisoning)	In canned food	<i>Clostridium botulium</i>	Man	Vomiting, constipation, paralysis of muscle, death.

Table 8.4 Fungal Diseases

	Disease	Causative organisms	Mode of transmission	Host	Main symptoms
1.	Ring-worm of the scalp	—	<i>Microsporum audouini</i>	Young children	It is very contagious. It spreads through personal contact; combs, hats, head tie. It starts as a small scaly, roundish spot which enlarges if not treated immediately.
2.	Ring-worm of the feet (Athlete's foot)	—	<i>Tinea pedis</i>	Man-all ages	It appears in between wet toes. The affected part is whitish.
3.	Ringworm of the skin e.g. (Dhobi itch)	—	<i>Microsporum canis or audouini</i>	Children	Skin lesions as peeling, scaly discs. It causes inflammation, swelling and blistering.

Table 8.5 – Diseases spread by personal contact

	Disease	Causative organisms	Mode of transmission	Host	Main symptoms
1.	Gonorrhoea	A bacterium <i>Neisseria gonorrhoea</i>	Sexual intercourse	Infected man or woman	Urethra is inflamed. Burning sensation and pain during urination. Thick, yellowish discharge from penis or vagina. Infected pregnant mothers may infect the babies' eyes with the germs. It may lead to blindness in the babies. It may also cause sterility.
2.	Syphilis	A bacterium <i>Treponema pallidum</i>	Sexual intercourse	Infected person	Sore (canker) on penis or vulva. A mild fever, skin rashes and mouth ulcers and aching pains in the lymph nodes. It may cause repeated abortions. The germs may attack the brain, cause blindness, insanity or loss of control of movement.
3.	AIDS	A virus	(i) Sexual intercourse (ii) transfusion of unscreened infected blood (iii) from a pregnant woman to the unborn child (iv) sharing sharp instruments like blade with infected person	Infected person	Wasting away of muscles and death.

Other venereal diseases (VD) are urethritis and herpes which are caused by viruses. Trichomoniasis is caused by a protozoan while thrush is a fungal disease.

Bacteria cause great damage and loss to certain crops. They cause blights, leaf spots, mildews, smuts, rusts, wilts and rots of crops such as yam, cassava, maize and rice.

Some fungi cause a lot of economic loss as a result of the damage done to certain crops, e.g. potato blight by *Phytophthora*. They cause diseases in rice, wheat, maize, cotton and grape. They also destroy wooden structures (dry rot), stored grains, fruits and vegetables. Some fungi e.g. *Mucor* decompose or spoil our cooked foods, fresh foods, fruits and vegetables. They soften the food, make it messy, smelly and unfit for eating.

Animal diseases

The micro-organisms are transmitted through agents such as air, water, food, vectors or carriers, cuts and scratches, faeces and personal contact with those who have certain diseases. See [Table 8.1 – 8.5](#). It is possible to transfer infectious diseases from one person to

another or from animals to man. Contagious diseases are those diseases which can be contracted by direct contact with a diseased person e.g. sexually transmitted diseases. Others are leprosy, colds, measles and tuberculosis.

Suggested Practicals

The class should be grouped into two. Group A should be asked to perform experiments on fermentation of palmwine or a sugar solution to produce alcohol.

1. *Fermentation: Production of alcohol - Group A*

- (a) Make a solution of glucose (10gm) in distilled water (90ml), in a 250ml beaker.
- (b) Pour the solution into test tubes A and B to reach the same level
- (c) Add to A, a measure of yeast and leave B as control for one day.
- (d) Observe the set up.
- (e) Note any bubbles coming out in either A or B. Note the smell in the test tubes and compare it with that of ethanol in the laboratory.

Test B is the control. Nothing has changed in it. In A however, bubbles of (Carbon(IV) oxide) were seen coming out. The smell similar to that of ethanol (alcohol) was noticed in it. The conclusion is that the micro-organisms (i.e. yeast), produce alcohol from sugar solution.

2. *Curdling of Milk - Group B*

- (a) Take a tin of milk and pour equal quantities in beakers A, B and C, each 250ml.
- (b) Add water to fill up A, and half-fill B and C.
- (c) Boil A for about 10-15 minutes.
- (d) Cover the mouth and seal up properly with an adhesive tape.
- (e) Introduce a dilute acid e.g. lime juice to B. Do nothing to C (control).
- (f) Leave all the beakers in the same place for three days.
- (g) Observe them and taste the contents of each beaker after 24 hours.
- (h) Record your observations i.e. taste, effect of heating A, and addition of lime to B.

Discuss the findings with your mates (under the teacher's supervision) e.g. boiling milk in A and sealing it up prevented entry of bacteria and killed those in it. Adding lime juice to B increased its acidity and it favoured the growth of bacteria. Nothing happened to C - the control.

Summary

1. Micro-organisms are tiny organisms. They cannot be seen with the naked eyes except with powerful microscopes.
2. They are grouped into viruses, bacteria, algae, protozoa and fungi.

3. Microbes vary in size, shape, structure and colour.
4. They are found almost everywhere in the world. They are found in water, soil, air, food, plants and, on or in our bodies.
5. They can be studied in the laboratories. There, they grow and multiply in culture media in the form of colonies.
6. Micro-organisms are spread by air, water, food, vectors, wounds and personal contact.
7. Vectors of micro-organisms include insects e.g. mosquito, tsetse fly and housefly.
8. Some micro-organisms are beneficial while others are harmful.
9. Beneficial micro-organisms are useful in agriculture, medicine and industries.
10. Some micro-organisms destroy food and can be poisonous. Others cause various diseases in plants and animals, including man.

Objective Questions

1. Which of these organisms cannot exist on its own?
 - A. A virus
 - B. A bacterium
 - C. A fungus
 - D. An alga
 - E. A protozoan.
2. Which of the following statements is false.
 - A. Micro-organisms are very tiny organisms.
 - B. Micro-organisms can be found in air and water.
 - C. Micro-organisms exist inside our bodies.
 - D. Micro-organisms can be observed with hand lens.
 - E. Vectors such as houseflies are dangerous because they spread pathogenic micro-organisms.
3. In alcoholic fermentation, one of these statements is untrue.
 - A. It is a form of anaerobic respiration.
 - B. A lot of energy is produced.
 - C. It involves the action of yeast or bacteria on starch or sugar.
 - D. It is catalyzed by an enzyme complex called zymase.
 - E. Carbon(IV) oxide and alcohol are produced.
4. Which of the following statements is false?
 - A. Parasitic bacteria cause diseases.
 - B. Micro-organisms are spread by air, water, food and personal contact.
 - C. Saprophytic bacteria and fungi spoil our food.
 - D. Some bacteria are useful in the production of antibiotics.
 - E. Very many protozoans cause diseases in man.
5. Which of the following statements is not correct?
 - A. The growth of a bacterium may be studied in the laboratory with the aid of pure culture.

- B. The growth of bacteria can be observed by the increase in the number of cells or size of colonies.
- C. The growth of bacteria is not affected by temperature or availability of food.
- D. A culture medium is a sterile medium suitable for growing micro-organisms.
- E. Micro-organisms are found in almost all environments.

Essay Questions

1. Write brief notes on the economic importance of micro-organisms to man with special reference to agriculture, medicine and industry.
- 2(a) List two diseases carried by vectors, water, air and personal contact.
- (b) Indicate how these diseases are spread from one person to another.
3. Describe briefly, how the presence of microbes can be detected in the laboratory.
- 4(a) Name two diseases each, caused by (i) viruses (ii) protozoans and (iii) bacteria.
- (b) State the symptoms of each disease.