

MODERN BIOLOGY

PRACTICAL AND WORKBOOK



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23456789S98



PREFACE

Modern Biology Practical and Workbook provides a quick and easy revision course in Biology, as well as a means for testing and evaluating the student's theoretical and practical knowledge. It has been written to accompany the highly successful **Modern Biology (Revised Edition)**, but it may be used with any other textbook on the subject.

This book organizes materials under broad headings, providing synopses of important topics for easy reference and recall. It contains a wide variety of exercises and experiments to test the student's understanding of the subject matter and promote skills in observation and practical work. The exercises are well graded and thought-provoking, requiring a firm grounding in biology principles and concepts. The experiments, simple and interesting, will challenge student resourcefulness and encourage more independent activity. The book also includes useful hints on basic techniques and procedures to help students conduct experiments properly.

Before beginning an exercise, the student is advised to read up on the relevant topic. This will make the exercise easier to understand and to do. Where examples of specimens suggested are not available, teachers can replace them with other suitable ones. To make field trips more meaningful, they could brief students on what to look for and help them identify unfamiliar specimens. Students could then be encouraged to make reports of the living things they see in their natural environment.

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INTRODUCTION

This is a Biology practical book as well as a workbook containing revision exercises and specimen examination papers. Given below is a list of useful hints which you should observe when carrying out the practical and revision exercises in this book.

1. The writing up of an experiment should be done in the following manner:

Aim: State the objective of the experiment, e.g. To demonstrate osmosis.

Apparatus/Materials: The things needed during the course of the experiment.

Method/Procedure: The steps taken to set up the experiment.

Observation: What is seen to take place during the experiment.

Results: Figures that have been recorded.

Conclusion: Statement confirming or disproving the aim.

2. The method or procedure should be written in the passive form, e.g. Two potted plants are/were covered with bell jars and put in a cool place. They were observed from time to time..... and not in the active form, e.g. Take two potted plants. Cover them with bell jars and put or We/I took two potted
3. If any precautionary measures were taken during the experiment, they should be included under **Method/Procedure** together with the reasons for taking them, e.g. The surface of the soil was covered with polythene sheet to avoid evaporation of water from the soil.
4. Always make large labelled relevant diagrams when writing up an experiment or in an essay. In both cases make references to the diagrams, e.g. in a write up of an experiment — **Method:** The test tube was filled with water and inverted over the arm of the funnel as shown in the diagram or **Observation:** Little drops of liquid were seen on the inner walls of the bell jar as shown in the diagram; in an essay — The body of the animal is divided into segments as shown in the diagram.
5. Use an H.B. pencil for the diagrams. Label and rule lines in pencil as this will facilitate correction.
6. As far as possible the label lines should be horizontal and the label should be written neatly against it and not on the top of it. (Refer to the labelling of the diagrams in number 7.)
7. The diagrams should be proportionate.

For example



8. The diagram should have an appropriate heading and where actual specimens are being drawn in practicals the magnification should be stated. In the case of limbs of animals, the side of the body from which the specimen has been taken should also be stated, e.g. Diagram of the left humerus of a mammal.
9. In sectional diagrams, the cut surface should be indicated to show that the diagram represents a section.

For example



1. CLASSIFICATION

BACKGROUND INFORMATION

Living things can be classified into two major groups or kingdoms—the Plant Kingdom and the Animal Kingdom. Within these two groups, there are many kinds of organisms which have been grouped under several subdivisions. This classification is based mainly on similarities and dissimilarities in the morphology, anatomy, physiology and mode of life of the living organisms. Organisms that are very similar are grouped together while those that are not so similar are put in separate groups.

PLANT KINGDOM The Plant Kingdom is divided into several major groups—the bacteria, the algae and fungi, the mosses and liverworts, the ferns and the seed-bearing plants.

Bacteria (Schizophyta) These are unicellular non-green plants which lack a definite nucleus. (All other plants have definite nucleus.)

Algae and Fungi (Thallophyta) These have a body or thallus that is not differentiated into root, stem and leaf. The algae are green plants which can manufacture their own food, while the fungi are non-green plants which cannot make their own food.

1. Algae They are mainly aquatic plants which may be unicellular or multicellular. They occur in many colours, e.g. green, blue, red and brown. The colours depend on the types of pigments that are present. All algae contain the green pigment, chlorophyll, which is found in chloroplasts. The chloroplasts may be cup-shaped, star-shaped, ribbon-shaped, or spiral. The green algae only contain the pigment chlorophyll. The colour of the brown algae is caused by a pigment called fucoxanthin, while that of the red algae is caused by a pigment called phycoerythrin.

2. Fungi They are non-green plants because they lack chlorophyll. Most of them are parasitic or saprophytic. A few fungi are unicellular but most of them are multicellular and filamentous. The filaments usually form a network called mycelium. The yeast is a unicellular fungus while the *Rhizopus* is a multicellular filamentous fungus.

Mosses and Liverworts (Bryophyta) They are multicellular green plants which have structures like leaves, stems, and roots. The stem is short and the roots are called rhizoids. They are non-vascular plants. The *Selaginella* is an example of a bryophyte.

Ferns (Pteridophyta) They are multicellular, non-flowering, vascular green plants which have leaves, stems and roots. The stem is a rhizome and the leaf is called a frond. They have adventitious roots. They reproduce by spores. *Platycerium* and *Polypodium* are examples of ferns.

Seed-bearing Plants (Spermatophyta) These can be grouped into gymnosperms and angiosperms. They are seed-bearing green plants which have a true vascular system, leaves, stems and roots.

1. Gymnosperms They are non-flowering, seed-producing vascular plants. The seeds are borne naked on scale leaves in cones. The whispering pine (conifer) is an example of a gymnosperm.

2. Angiosperms They are flowering, seed-bearing vascular plants. Seeds are produced from ovules enclosed in ovaries. They are grouped as dicotyledons and monocotyledons.

a. Dicotyledons These have two seed-leaves called cotyledons. The leaves have network venation. The petals of flowers are arranged, generally in groups of four or five. The bean plant, *Crotalaria* and sunflower are examples of dicotyledons.

b. Monocotyledons They have one seed-leaf and the leaves have parallel venation. The petals of flowers are arranged in groups of three or multiples of three. The maize, palm and lilies are examples of monocotyledons.

ANIMAL KINGDOM The Animal Kingdom is divided into two main groups—the invertebrates and the vertebrates.

Invertebrates These are animals which lack internal skeletons and vertebral columns. They are subdivided into protozoa and metazoa. Protozoans are unicellular animals which may be free-living or parasitic. Metazoans are multicellular animals which are made up of the following groups—coelenterates, platyhelminthes, molluscs, annelids, arthropods and echinoderms. The arthropods are a very large group which include the crustaceans, insects, myriapods and arachnids.

Vertebrates These are animals which have internal skeletons of bone and/or cartilage and vertebral columns. They are subdivided into five groups—fishes, amphibians, reptiles, birds and mammals.

PROBLEMS FOR STUDY 1.1 WHAT ARE THE DIFFERENT GROUPS OF PLANTS?

This is an example which shows how you can identify and classify the following plant groups:

Bacteria	Dicotyledons	Monocotyledons	Algae
Ferns	Fungi	Liverworts and Mosses	Conifers

1. a. Plants which lack definite nucleus
Bacteria
b. Plants with definite nucleus
(see 2)
2. a. Flowering and seed-producing plants
(see 3)
b. Non-flowering plants
(see 4)
3. a. Plants with network venation
Dicotyledons, e.g. bean
b. Plants with parallel venation
Monocotyledons, e.g. maize
4. a. Vascular non-flowering plants
(see 5)
b. Non-vascular, non-flowering plants
(see 7)
5. a. Non-flowering seed-producing plants
Conifers, e.g. whispering pine
b. Non-flowering seedless plants
(see 6)
6. a. Non-flowering plants without true stem and root
Liverworts and Mosses, e.g. Selaginella
b. Non-flowering plants with true stem and roots.
Ferns, e.g. Platycerium
7. a. Green plants which are unicellular and filamentous
Algae, e.g. Spirogyra
b. Non-green plants which are unicellular and filamentous
Fungi, e.g. Rhizopus

EXERCISES

1. Now study the example above carefully and use it to identify and classify the following:
Penicillium, Chlamydomonas, a moss plant, an oil palm seedling and a bean seedling.

Text: To identify and classify the above plants

a.



1.2 WHAT ARE THE MAJOR GROUPS OF ANIMALS?

EXERCISES

1. a. In the space below list the major groups of vertebrates and invertebrates.

Vertebrates	Invertebrates

b. Why are the above called vertebrates?

.....

.....

.....

.....

c. Why are the above called invertebrates?

.....

.....

.....

.....

.....

2. List four important external features of each vertebrate group, which help to distinguish it from the others.

Fishes

Amphibians

Reptiles

- a.
- b.
- c.
- d.

Birds

- a.
- b.
- c.
- d.

Mammals

- a.
- b.
- c.
- d.

3. Complete this key for the identification of the various groups of vertebrates.
All vertebrates have an internal skeleton.
- 1. a. Vertebrates with scales covering the body.
 - (i) (ii)
(see 2)
 - b. Vertebrates without scales covering the body
 - (i) (ii) (iii)
(see 3)
 - 2. a. Vertebrates with dry scales forming a protective sheath or case
 - (i) e.g.
 - b. Vertebrates with movable overlapping scales and mucus
 - (i) e.g.
 - 3. a. Vertebrates with feathers covering the body
 - (i) e.g.
 - b. Vertebrates without feathers covering the body
 - (i) (ii)
(see 4)
 - 4. a. Vertebrates with hairs covering the body
 - (i) e.g.
 - b. Vertebrates with moist smooth skin or dry, warty or rough skin covering the body
 - (i) e.g.
4. Give an example of: a. an aquatic free-living protozoa
b. a parasitic protozoa
5. a. The two groups of metazoa which have soft bodies are (i)
(ii)
- b. The group which has a soft jelly-like body is called
An example is
- c. The group which has a soft body and possesses a shell is
An example is

6. a. The two large groups of arthropods are (i)
(ii)
b. The group with the exoskeleton made of cuticle (cuticular skeleton) is
An example of this group is
c. The group with the spiny exoskeleton made of calcium (calcareous skeleton) is
An example of this group is
7. The group of arthropods which generally have wings is called
An example is
8. a. Arthropods with an elongated cylindrical body and a distinct head are called
Examples are
b. Arthropods with the head and thorax fused which possess antennae are
Examples are
c. Arthropods with the head and thorax fused without antennae are
Examples are
9. Complete the classification table below.

Animals	
Vertebrates	Invertebrates
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
	6.
	7.
	8.
	9.

GENERAL QUESTIONS Each question is followed by four options. Put a tick against the correct option.

- Which pair of organisms is one-celled or unicellular?
A. *Spirogyra* and *Rhizopus* B. *Amoeba* and *Spirogyra*
C. bacteria and *Amoeba* D. *Rhizopus* and bacteria
- Which pair of organisms is multicellular?
A. *Hydra* and *Amoeba* B. *Hydra* and *Spirogyra*
C. *Spirogyra* and bacteria D. *Rhizopus* and *Chlamydomonas*
- Which of the following is not a simple multicellular organism?
A. *Hydra* B. *Spirogyra* C. *Amoeba* D. *Rhizopus*
- Which of these is an alga?
A. *Rhizopus* B. spider C. *Spirogyra* D. *Hydra*
- Which pair of plant groups is not non-flowering?
A. conifers and ferns B. algae and fungi
C. mosses and ferns D. dicotyledons and monocotyledons
- Which pair of plant groups is seed-producing?
A. fungi and algae B. mosses and ferns
C. mosses and conifers D. conifers and flowering plants

7. Which plant has two seed leaves (cotyledons) ?
 A. lilies B. palms C. beans D. grasses
8. Which plant does not have one cotyledon ?
 A. lilies B. palms C. orchids D. oranges
9. Which pair of animals is not invertebrates ?
 A. *Amoeba* and *Hydra* B. tapeworm and earthworm
 C. snail and starfish D. fish and toad
10. Which of these is the odd one out ?
 A. lizards B. birds C. tapeworms D. mammals
11. Which statement is true of vertebrates? All vertebrates
 A. are partly unicellular.
 B. have an internal body framework and a backbone.
 C. have an external body framework and a backbone.
 D. are usually simple multicellular organisms.
12. Which statement is true of invertebrates? All invertebrates
 A. are unicellular. B. have an external skeleton.
 C. lack backbones and internal skeletons.
 D. are simple microscopic organisms.
13. Which organism exhibits both plant and animal characteristics?
 A. *Hydra* B. *Spirogyra* C. *Amoeba* D. *Euglena*
14. Which is the simplest animal group?
 A. protozoans B. metazoans C. vertebrates D. coelenterates
15. Bivalves, slugs, oysters and scallops are examples of
 A. molluscs. B. arthropods. C. annelids. D. echinoderms.
16. Bristleworms and leeches are examples of
 A. coelenterates. B. annelids. C. arthropods. D. nematodes.
17. Which of these statements is false?
 A. A cell wall is absent in animal cells.
 B. Animals have a holophytic mode of nutrition.
 C. Most plants contain a green pigment called chlorophyll.
 D. Most animals have compact bodies and the presence of a definite symmetry.
18. Which of these statements is false?
 A. A mature plant cell has many minute vacuoles.
 B. Growth is limited in most animals.
 C. Organs of locomotion are absent in most plants.
 D. Most animals possess a nervous system which enables them to react quickly to external stimuli.

2. MICROSCOPIC ORGANISMS

BACKGROUND INFORMATION

Organisms which cannot be seen or clearly seen with the naked eye are called microscopic organisms. They include viruses, bacteria, unicellular animals like *Amoeba* and unicellular plants like *Chlamydomonas*. They also include simple multicellular plants and animals like *Rhizopus*, *Spirogyra* and *Hydra*.

Viruses Viruses are very minute organisms which can only be seen under an electron microscope. They can only exist and reproduce in a living medium like a bacterial, plant or animal cell. They are of economic importance because they cause diseases in plants and animals.

Bacteria Bacteria are unicellular organisms which differ from one another in size and shape. They reproduce rapidly by binary fission. During unfavourable conditions certain bacteria form spores which are light and easily carried by the air. Certain bacteria, like those which bring about decay, are useful to Man but a number of them cause diseases among plants and animals.

Microscopic Plants Simple microscopic plants belong to the group Thallophyta. Thallophytes consist of unicellular and multicellular plants. They have a simple body structure, with no definite stems, roots, leaves or flowers. They can be divided into algae

(mainly aquatic) and fungi (mainly terrestrial). Algae contain the green pigment chlorophyll which fungi do not. Fungi are therefore unable to manufacture food like algae and so they are either parasites or saprophytes. Both algae and fungi reproduce sexually and asexually and produce spores during unfavourable conditions. Fungal spores are light and are dispersed by air. When these spores fall on a suitable substrate, they will germinate and grow rapidly if the temperature and moisture content of the environment are right. They feed on the substrate on which they are growing by breaking down the organic material of the substrate into simpler substances. This process is known as decay. Bacteria and fungi are the two important organisms which bring about decay. Certain fungi cause diseases among plants and animals while others like the decay-causing and the antibiotic-producing fungi are useful to Man.

Microscopic Animals Microscopic animals belong mainly to the groups Protozoa and Coelenterata. Protozoans are unicellular animals without special body shape or sense organs. However they have specialized structures having definite functions. A number of them are parasites. Coelenterates are simple multicellular animals. They are radially symmetrical with a body cavity having a single opening to the exterior.

PROBLEMS FOR STUDY

2.1 DO ALL MICROSCOPIC ORGANISMS HAVE SIMILAR EXTERNAL CHARACTERISTICS?

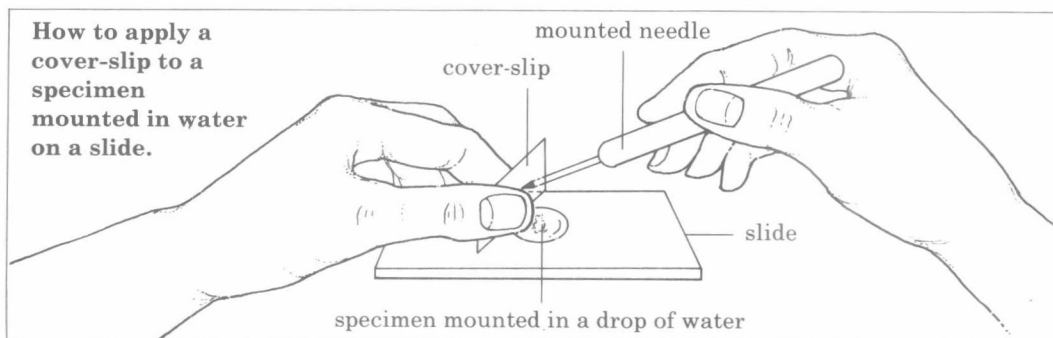
Investigation Materials

To examine various microscopic organisms.

Specimen *A* — a slide of a protozoa; Specimen *B* — a slide of a coelenterate; Specimen *C* — a slide of a green alga; Specimen *Da* — a slide of a fungi; Specimen *Db* — a mouldy orange, bread, kenkey or corn dough.

Method

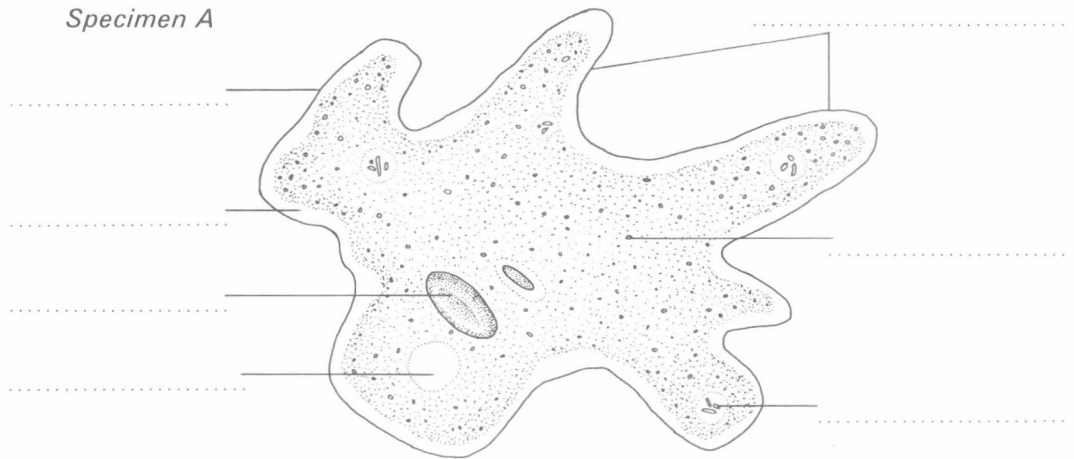
Examine the slides of Specimens *A*, *B*, *C* and *Da* under the microscope and identify the various structures of each specimen. Scrape off a small portion of the mouldy growth from Specimen *Db* and place it on a slide with a drop of water. Examine this under the microscope.



EXERCISES

1. Label the diagrams provided of Specimens A, B, C and Da and answer the questions which follow after each diagram.

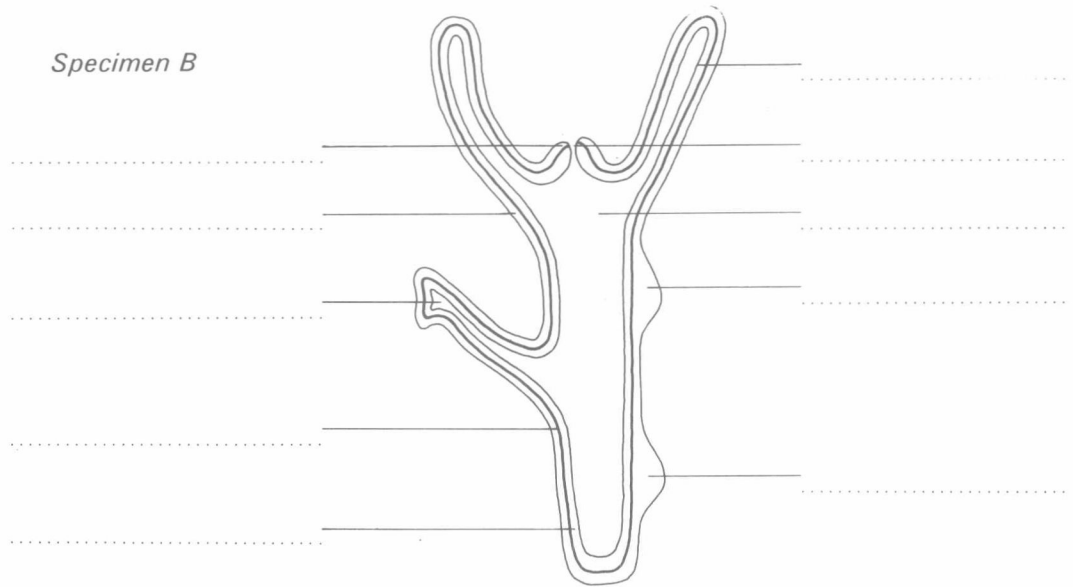
Specimen A



- a. Specimen A is made up of two types of cytoplasm, a clear and gelatinous outer layer called and an inner granular fluid-like layer called
- b. It regulates the amount of water in its body by
- c. It uses its pseudopodia for (i)
(ii)
- d. Food is digested in
- e. It exchanges gases with the surrounding water by means of
- f. Specimen A is a protozoan which lives in ponds and ditches. It is probably an
- g. By means of simplified diagrams and short notes illustrate reproduction in Specimen A.

Diagram to be drawn: Reproduction in Specimen A

Specimen B

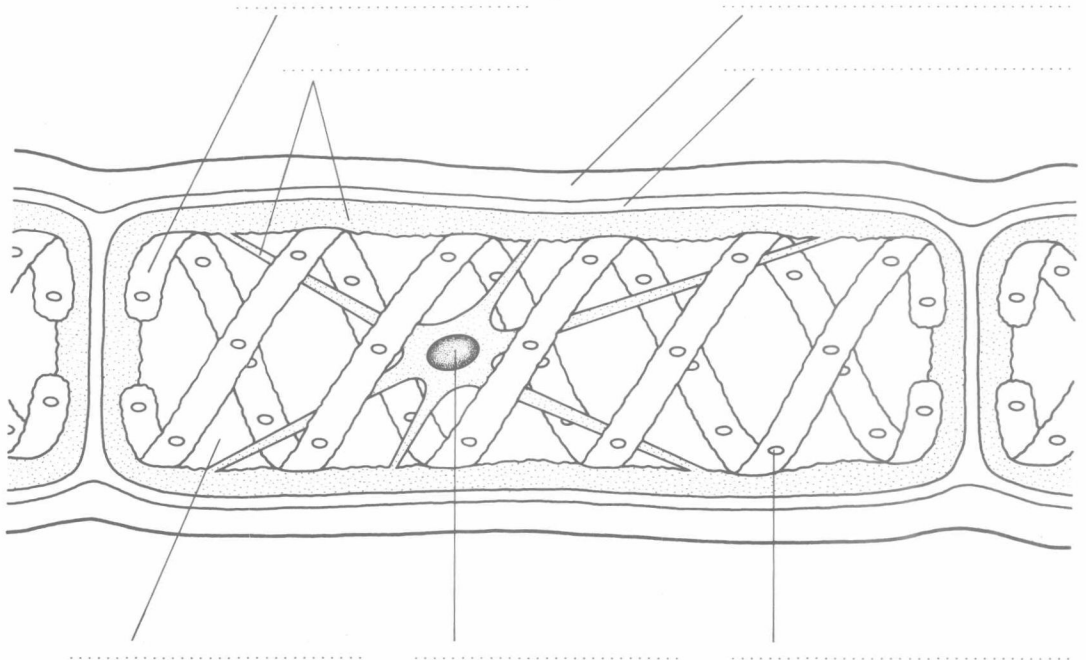


- a. The tentacles of Specimen *B* are used for
- b. The main function of the nematoblasts is
- c. Food is taken into the body through the on the top of the
- d. Food is partially digested in the Digestion is completed in the
- e. Undigested food is eliminated through the which thus serves as as well.
- f. Specimen *B* is able to adhere to the substratum because of produced by
- g. It exchanges gases with the surrounding water by means of
- h. Specimen *B* lives in fresh water. It is probably a
- i. Specimens *A* and *B* can be grouped as because both of them have structures for
- j. Draw simplified labelled diagrams to show sexual and asexual reproduction in Specimen *B*.

Diagram to be drawn: Sexual reproduction in Specimen *B*

Diagram to be drawn: Asexual reproduction in Specimen *B*

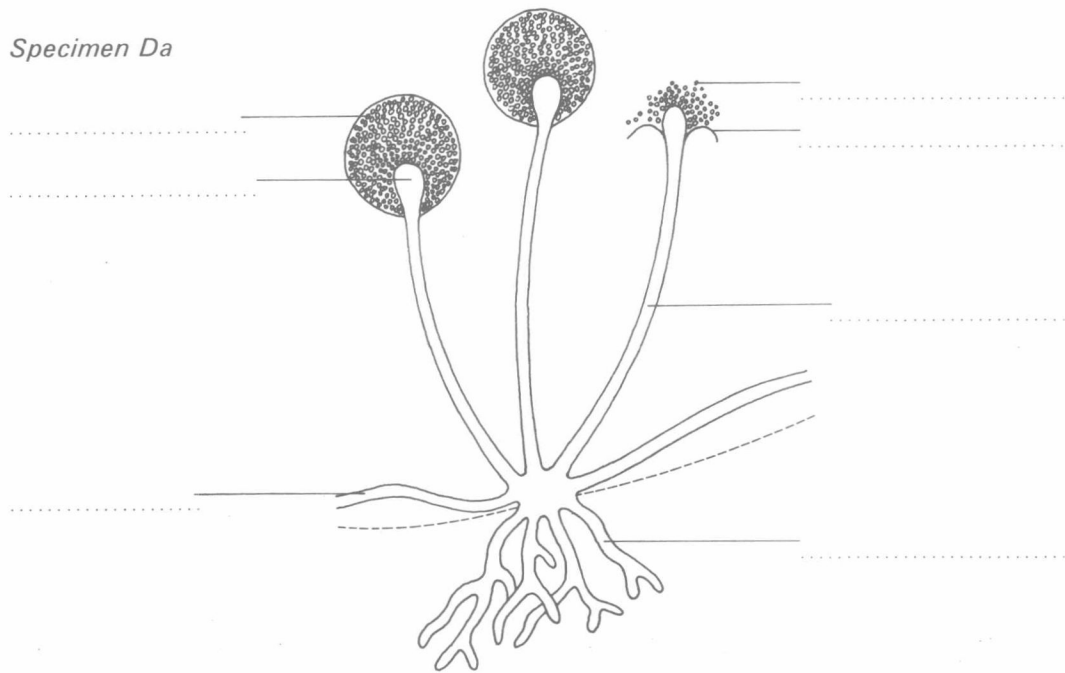
Specimen C



- a. Specimen *C* has a cellulose cell wall. Therefore it is a
- b. It has a green filamentous body structure, without any definite organs. Therefore it is an
- c. Specimen *C* is probably
- d. A filament of Specimen *C* is covered by a which prevents it from
- e. Specimen *C* reproduces vegetatively by
- f. By means of simplified labelled diagrams illustrate sexual reproduction in Specimen *C*.

Diagram to be drawn: Sexual reproduction in Specimen *C*

Specimen Da



a. Write a function for each of the following parts.

Rhizoids

Sporangiophore

Sporangium

Stolon

b. The mass of hyphae is called a

c. Has Specimen *Da* cross walls?

Its hyphae are therefore described as being

d. How does Specimen *Da* obtain its food?

e. What is a common characteristic of Specimens *C* and *Da* which enables them to be put under one group?

f. Specimen *Da* is a black mould which grows commonly on stale bread. It is probably

g. Make a sketch of the mould that is found growing on Specimen *Db*.

Diagram to be drawn: Mould growing on Specimen *Db*

2. Do all microscopic organisms you know have similar characteristics?