The essential parts of all microtome as previously outlined by Okoli are as follows:

(i). **A thickness gauge :** This enables student to select the desired thickness to be cut. It may range from (340 microns).

(ii). **Steel block carrier :** This tissue block is attached to this part (chuch)

(iii). **Clamp:** The microtome is clampled tightly to avoid vibration and cutting of sections of variable thickness.

(iv). **Wheel:** The turning of the wheel activate the cutting of section.

(v). **Knife:** Microtome knives are made up of steel and are normally heavy to minimize vibration height. Disposable knives are now available and are used to cut every tissue except hard tissues like testia of some seeds. Knives should be cared for to avoid rusting and serve injury to the students. This may come in various form e.g. plane edge, tool, edge biconcave or Piano-concave

Rules for section cutting

Below are rules for section cutting:

(i). Obtain the appropriate ***microtome*** that you want to use.

(ii). Select the thickness at which the section should be cut usually about 3-4 microns.

(iii).For animal tissues, cut between 4-6 microns, while 8-12 microns are preferable for plant tissues. ***Lymph nodes*** are best cut 2-3 microns.

(iv). The microtome knives should be kept quite sharp.

(v). The specimen block should be trimmed so that the wax is evenly spread around the material with the slide parable and mounted parallel to knife edge.

(vi). The microtome knife must be mounted at the correct angle and screwed tightly.

(vii).If the wrinkle appear during sectioning, it is advisable to cool the block with ice.

(viii). The mounting of ribbon on slides can be accomplished by smearing the required numbered of slide with the film or Maryer's albumen.

(ix). The index finger is usually used.

(x). The ribbons are laud on smeared slides and the slides are heated gently over a spirit flame for 2-3 seconds.

(xi). Cut the ribbons into short length than the coverslip to allow for stretching.

(xii). Float the ribbons on a few drops of alchohol or water on the slide placed on a hot plate at 45^{o}C to stretch and dry in 4-12 hours.

15.13.2 Micro- Techniques

Micro-techniquesare the art of preparing objects for examination under the microscope and preservation of the materials so prepared. A few specimens yield useful information if they are not subjected to preliminary preservation, hardening, making them transparent, colouration of parts and cutting into thin slices.

15.14 PREPARATION OF MOUNTS

Whole ***mounts***, ***smears***,***squashes***, and sections of tissues are usually preparation of plants and animal tissues meant for specific purpose. In the whole ***mount***, a student is given a chance to study an entire organism or specific organ structure in detail.

The study of cells requires the preparation of sections of that particular cell. Such sections may be useful in the study of normal and ***pathological material***. ***Smears*** are usually used for bacteriological and blood examination.

15.14.1 Fixation and preservation

Specimen can be preserved in any physical or chemical environment provided enzyme action and microbial growth are both prevented. It is important to fix the specimen before preservation in order to obtain a facsimile of the appearance when they are living. Certain specimens require immobilization of highly contractile creature and this is obtained by instant denaturing of proteins, while preservation of such protoplasmic structure is best retained by slow tanning. The following fixative solutions may include osmic-chromic acetic, chromic-acetic formaldehyde, picric-acetic, dichromate-mercuric acetic and mercuric acetic solutions. It is the practice to remove free fixative by washing in water. Trinitrophenol fixed specimens must be washed in 70% ethanol to avoid the removal of water soluble albumen, trinitrophenol complexes. After washing the specimens, they are preserved in 70% ethanol or 4% formaldehyde except specimens fixed with trinitrophenol.

(a) Staining:

A dye is any coloured substance that when combined with a second substance imparts a colour to that substance. Acid dyes and basic dyes are often used in staining microscopic specimens. The former is the colour bearing ions and is used to colour the nucleus, while the latter is used to colour some basic and acidic dyes from a component known as neutral dyes which may be used for staining both nucleus and cytoplasm from a single cell. Basic dyes can be applied to the microscopic specimens in form of water solution on weak ethanol. After dyes treatment hematoxzylin which picks the acid must be treated with a weak alkali. It is noteworthy that environmental factors such as ionic concentration, temperature of composition and pH can affect the staining reaction in a cell. The cellular structures that stain with acid stains are called ***acidophilic*** and those that stain with basic dyes are called ***basophilic***.

15.14.2 Preparation of Temporary or Wet Mounts

This is among the simplest procedure in microscopyand the method will be adopted:

(i). Place a small drop of water on a clean slide. If the material is in liquid, place a drop of the ***suspension*** on the slide.

(ii). Place the biological specimen (cell) in the drop of water.

(iii). The specimen is covered with a cover glass by first placing one edges of the cover glass on the slide and then lowering the opposite edge with a dissecting needle. This will reduce the trapping of air bubbles.

(iv). Permit water to fill the space between the slide and the cover glass. If excess water spreads over any other part of the slide, remove it with blotting paper or towel.

(v). Remember to place a drop of water as the specimen begins to dry.

(vi). Replace the water with another medium without disturbing the specimen.

(vii). A piece of absorbent paper should be placed at the edge of the coverslip and a drop of a new medium at the opposite edge.

(viii). Oil immersion objective can be used if care is taken to hold the cover in place.

(ix). The organisms are best observed if the light intensity is diminished or a dark-filed or phase contrast illumination is used (Frobisher *et al,* 1974).
Clearing may be accomplished with the use of clove oil and thyme oil although terpineal can also be used but it will render the specimen less brittle. The specimen will be removed from the clearing agent and placed in a drop of Canada balsam on the slide. A cover slip is then lowered vertically in place.

15.15 SMEARS

Smears are most commonly prepared using ***microscope slides*** in the laboratory.
The method of Gray (1964) will be adopted for preparation as follows.

(I). Obtain a drop of organic fluid such as blood.
(ii). Place it on the end of clean slide.
(iii). Obtain a second slide and allow it to touch it and push forward to leave a uniform film.
(iv). Stain the specimen with Wright stain (this requires a phosphate buffer with a pH of 6.1).
(v). Air dry the smear and floods it with a specific stain and lay it on the rack for 1min.
(vi). Add a buffer to each drop of stain.
(vii). After 2min wash away the mixture with distilled water.
(viii). Preserve it in a dry state.

15.16 SQUASHES

These are specimens that are compressed in small place. The success of squash greatly depends on the condition of the material selected. Specimens like anthers of plant or testis of insects may be squashed directly. However, materials like the root tips plant ovaries require softening before squashing.

15.17 MOUNTING

In order to undergo a final examination under the ***microscope*** and for preservation**,** the section will have to be mounted in a suitable medium of about the same refractive index of 1.5 (Willis, 1965). ***Microscopic slides*** consist of two mounts namely: ***temporary mount*** and ***permanently mount***.

15.17.1 Preparation of Normal Saline Solution in the Laboratory

Normal saline solution (NSS) is commonly used in various laboratory procedures such as the preparation of Red cells ***suspension*** for the cross match, for preparing dilutions of Reagents, for stool examinations, to make the dilutions in serological tests, diagnostic etc. There are commercially prepared Normal saline solution available in the market but it can easily be prepared manually in the laboratory whenever required. The normal saline solution is simply the 0.85% sodium chloride (NaCl) solution which can be prepared in the laboratory by dissolving the calculated amount of sodium chloride crystals in the required quantity of distilled water.

15.17.2 Permanently mounts

Canada balsam is the best mounting medium commonly used and it dissolves in xylem (R.1 about 1.524). Euparal (R. about 1.4) can also be used whether or not dehydration is completed. De PRX (DPX) is miscible with xylene and has other advantages such as being neutral, colourless and quick drying. De PRX is strongly recommended for permanent mounts. These methods, according to Wallis (1965) are suitable for ***animal tissues*** generally. These methods of Wallis (1965) will be used

(i) place a drop of Canada balsam on the center of a clean slide.
(ii) Transfer the section to the balsam with a section lifter.
(iii) Cover with a clean cover slip by resting the cover slip against the finger and levering it down with a mounted needle.
(iv) This process will prevent the entrance of air bubbles. If there are any air bubbles, it can be removed by gentle warming the slide over a very small flame. Alternatively, the slide may be immersed in a fluid which will dissolve the mountant and loosen the cover slip e.g. xylene. The mounting procedure may then be repeated. Excess mountant is whipped off the edges of the coverslip with care and the slide left to dry out on a hot plate or in a 37^0C oven.
(v) The presence of a white film in the balsam indicates incomplete dehydration.
(vi) Label the slide and leave it to dry. To keep your prepared microscope slides in good condition, always store them in a container made for the purpose and away from heat and bright light.

15.18 REPORTING OF LABORATORY EXPERIMENTS AND DATA PRESENTATION

Before beginning any experimental investigation, the aim of the experiment should be made clear. This may involve the testing of a hypothesis, such as 'The ***germination*** of seeds requires the presence of water, oxygen and an optimum temperature' or a more open-ended investigation, such as 'What is the effect of light on the behavior of woodlice?' In both cases the experiment must be designed so that it can be performed, and the data produced should be reliable, relevant to the aim and hopefully used in producing a conclusion.

15.18.1 Reporting of Experiment

All experiments should follow a logical progression in reporting of the experiment.

(i) Title: This should be a clear statement outlining the problem to be investigated. For example '*Experiment to investigate the effect of pH on enzyme activity'.* It should be a broad statement of intent which is made specific by the hypothesis or aim.

(ii) Hypothesis or aim: This is a statement of the problem or the posing of a question. It may include an indication of the variables under examination and the possible outcome of the investigation. For example 'To investigate the effect of solutions of pH 2-10 on the rate of digestion of the protein albumin by the enzyme pepsin and to determine theoptimum pH of the reaction'.

(iii) Method or procedure: This is an account of the activities carried out during the performance of the experiment. It should be concise, precise and presented logically in the order in which the apparatus was set up and the activities performed during the experiment. It should be written in the past tense and not in the present tense. Using the information given, another scientist should be able to repeat the experiment.

(iv)Results and observations: These may be qualitative or quantitative and should be presented as clearly as possible in some appropriate form or forms, such as verbal description, tables of data, graphs, histograms, bar charts, and so on. If several numerical values are obtained for repeated measurements of one variable, the mean (x) of these values should be calculated and recorded.

(v) Discussion: This should be brief and take the form of the answer(s) to possible questions posed by the hypothesis, or confirmation of the aim. The discussion should not be a verbal repetition of the results, but an attempt to relate theoretical knowledge of the experimental variables to the results obtained.

(vi) Conclusion: This may be included if there is clear-cut verification of the stated aim. For example, for the aim given in (ii) above a conclusion could state that there is 'a relationship between pH and enzyme activity and for this reaction the optimum pH is x'. The discussion of the results of this same experiment should include such theoretical aspects as the nature of the reaction and the possible chemical and physical aspects of the effects of pH on the three-dimensional structure of enzyme molecules.

15.18.2 Presenting Data

As a result of qualitative and quantitative investigations, observations are made and numerical data obtained. In order for the maximum amount of information to be gained from investigations, they must be planned carefully and the data must be presented comprehensively and analyzed thoroughly.

(a) Tabulations

Tables form the simplest way of presenting data and consist of columns displaying the values for two or more related variables. This method gives neither an immediate nor clear indication of the relationship between the variables, but is often the first step in recording information and forms the basis for selecting some subsequent form of graphical representation.

(b) Graphical Representation

A graph is a two-dimensional plot of two or more measured variables. In its simplest form, a graph consists of two axes. The vertical y axis bears values called ordinates which show the magnitude of the dependent variable. This is the 'unknown quantity', that is the variable whose value is not chosen by the experimenter. The horizontal x axis bears values called abscissae which show the magnitude of the independent variable, which is the known quantity that is the variable whose value is chosen by the experimenter.

The following steps are used in constructing a graph.

(i). The scales and intervals for each axis should match the magnitude of the variables being plotted and fill the graph paper as completely as possible.

(ii). Each axis should begin at 0, but if all the values for one variable are clustered together, such as ten points lying between 6.12 and 6.68, a large scale will be required to cover these points. In this case, still begin with the axis at 0 but mark a break in the axis, marked as / /, just beyond.

(iii). Each axis must be labeled fully in terms of the variable, for example 'temperature/C' and have equally spaced intervals covering the range of the intervals covering the range of the interval, such as 0-60 at 12 five-unit intervals.

(iv). The points plotted on the graph are called coordinatesand represent the corresponding values of the two variables, such as when x = a y = b.

(v). Actual points should be marked by an X orand never by a dot only.

(vi). The points marked on the graph are the record of the actuals observations made and may be joined by a series of straight line segments drawn with a ruler, by a smooth curve or, in some cases, a regression line (a line of best fit). Thesegraphs are called line graphs**.** Straight line segments and smooth curves are preferable to a regression line.

(vii). The graph should have a full title, such as 'Graph showing the relationship between'.

(viii).Only the points on the graph represent actual data, but estimates of other values can be obtained from reading off coordinates at any point on the line. This is called interpolation. Similarly, coordinates outside the range of the graph may be determined by extending the line of the graph, a technique known as extrapolation.In both cases it must be stressed that these values are only estimates. In graphs where the *x-axis is* 'time', the steepness of the curve or gradientat any point can be calculated and this gives a measure of the rate of change of the variable under investigation. The value of the *y* interval is then divided by the value of the *x* interval and this gives the rate of change in terms of the units used in labeling the graph.

15.19 CHAPTER SUMMARY

- As in all experimental sciences, cell biology research depends on laboratory methods that can be used to study cell structure and function.
- Because most cells are too small to be seen by the naked eye, the study of cells has depended heavily on the use of microscopes, and the two types of microscopes are the light microscope and the electron microscope.
- Indeed, the very discovery of cells arose from the development of the microscope.
- Robert Hooke first coined the term "cell" following his observations of a piece of cork with a simple light microscope.
- Using a microscope that magnified objects up to about 300 times their original size, Antony Van Leeuwenhoek was able to observe a variety of different types of cells,including sperm, red blood cells, and bacteria.

- Cells achieved their current recognition as the fundamental units of all living organisms because of observations and reports of experiments conducted with the help of a microscope.
- Many important advances in understanding cells have opened moral avenues of investigation.
- The main methods of placing samples onto microscope slides are wet mount, dry mount, smear, squash and staining.
- An appreciation of the experimental tools available to cell biologists or cytologists is thus critical to understanding both the current status and future directions of this rapidly moving area of science.
- After viewing samples under a microscope, a report has to be made using the following: title, hypothesis or aim, method or procedure, result and observations, discussion, and conclusion.
- Data can be presented in the following forms: Tabulations and graphical representations.

15.20 STUDENTS' PRACTICAL ACTIVITIES

ACTIVITY 1: EXAMINATION OF WET MOUNTS
AIM: To observe wet mount of samples that may contain microorganisms

MATERIALS
(i) Slide,
(ii) Cover slips,
(iii) Microscope,
(iv) Bunsen burner,
(v) Wire loop,
(vi) Pasteurs,
(vii) Apelte,
(viii) Fermenting Palm wine,
(ix) Pond water.

PROCEDURE
(I). Shake the sample container of fermenting palm wine and pond water and use sterile Pasteurs pipette to add a drop of the sample on a clean slide and cover with a cover slip (seperately for each sample).
(ii). The wet mount preparations are sealed with parafin wax, nail varnish or melted vasaline oil at the edges of the gue ship to prevent drying of the suspension and to avoid air bubbles.
(iii). Examine the samples under low and high power objectives
(iv). Carefully draw your observations under the high power objective

ACTIVITY 2: EXAMINATION OF STAINED MICROBIAL CELLS
AIM: To examine stained microbial cells and compare with wet mounts in Activity (I) above.

ACTIVITY 3: Studying the Use of Microscope
AIM: To Study how Light Microscope is used (see Figure 15.6).
MATERIALS
Microscope
Prepared microscope slide

Note: Study your microscope carefully and compare it with the diagram below (Figure 15.6).
Yours may be slight different. Identify each of the labeled parts.

PROCEDURE

(i). Place a drop of immersion oil on the center of the stained sample
(ii). Examine with the oil immersion objective
(iii). Carefully draw your observation
(iv). Clean the oil from the objection lens with the Appropriate lens paper. Do this each time you use the oil immersion objective

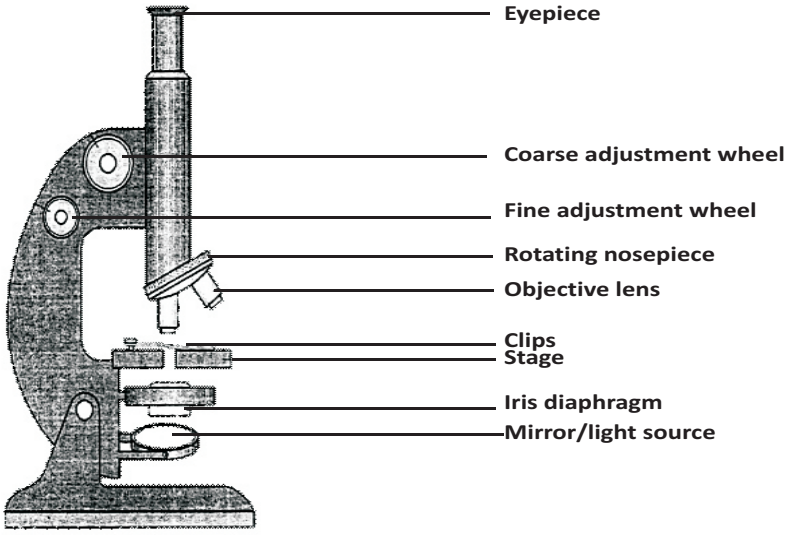

Figure 15.6: The light microscope.
Source: NIOS (2017).

PROCEDURE

(i) Familiarize yourself with all procedures before starting.
(ii) Switch on the light source and remove the eyepiece cover, if present.
(iii) Rotate the nosepiece so that the low power lens is used.
(iv) Put a prepared microscope slide on the stage of the microscope
(v) Move the slide until the object is above the hole in the stage.
(vi) Use the stage clips to hold the slide in place.
(vii) Using the coarse adjustment wheel, ensure that the low power lens is at the closest setting to the slide.
(viii) Look down on the eyepiece. Keep your eye about 2cm from the eyepiece. Adjust the iris diaphragm so that the field of vision is bright but not dazzling. Adjust the position of the slide, if necessary.
(ix) Use the coarse adjustment wheel to focus. If necessary, re-adjust the iris diaphragm so that the specimen is correctly illuminated.
(x) To increase the magnification, rotate the nosepiece so that the next highest power objective lens is above the specimen.
(xi) Refocus using the fine adjustment wheel. Re-adjust the illuminator if necessary.
(xii) To further increase the magnification, rotate the nosepiece again so that the highest power objective lens is immediately above the specimen.

15.1 TUTOR MARKED ASSESSMENT QUESTIONS

HAVING READ THROUGH **CHAPTER FIFTEEN**, ANSWER THE FOLLOWING QUESTIONS IN THE SPACES PROVIDED.

1. (a) Mention **Four** types of Light Microscope you have studied.

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4×½ =2 Marks

(b) Diagrammatically compare the Light Microscope with an Electron Microscope.

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4×½ =2 Marks

(c) State **Six** advantages of Light Microscope?

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4×½ =2 Marks

(d) State **Six** disadvantages of Electron Microscope?

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6×½ =3 Marks

2. (a) State **Six** procedures undertaken when cleaning a Microscope?

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(b) In a tabular form give **Three** (i) advantages and disadvantages of transmission Electron Microscope **$6\times\frac{1}{2}$ =3 Marks**

Advantages	Disadvantages

$6\times\frac{1}{2}$ =3 Marks

(c) Describe the working principle and the contribution of the Electron Microscope to the study of Cell Biology.

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$4\times\frac{1}{2}$ =2 Marks

(d)Write short note on Cell Culture?

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$4\times\frac{1}{2}$ =2 Marks

3. (a) With the aid of Annotated Diagramme represent the main Steps taken during Cell Fractionation.

Labeling $4\times\frac{1}{2}$ =2 Marks
Drawing $4\times\frac{1}{2}$ =2 Marks

(b) What is staining?

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$2\times\frac{1}{2}$ =1 Marks

(c) How does a smear differ from whole mounts?

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$3\times\frac{1}{2}$ =$1\frac{1}{2}$ Marks

(d) Describe how to prepare a smear on a microscopic slide.

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$4\times\frac{1}{2}$ =2 Marks

(a) Highlight **Six** safety precautions when using a Microscope.

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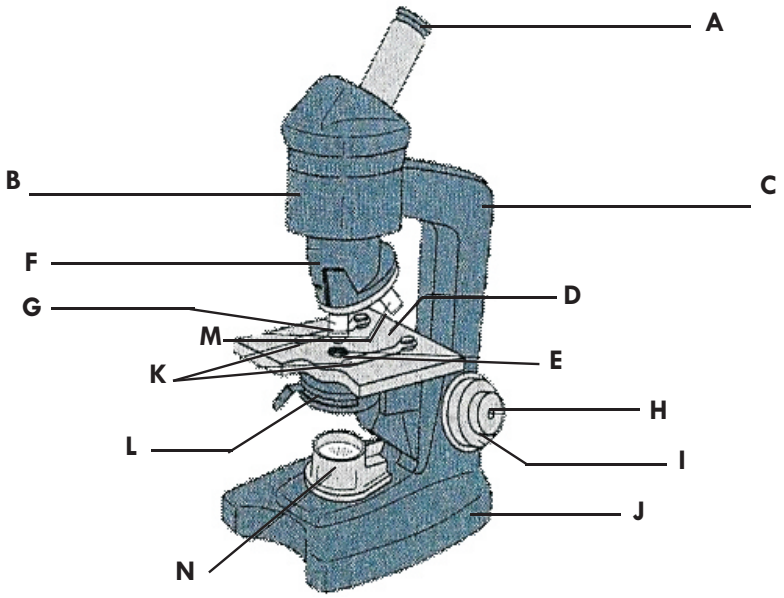
$3\times\frac{1}{2}=1\frac{1}{2}$ Marks

(b) Study the structure of a Compound Microscope below and labell the parts **A to N.**



$10\times\frac{1}{2}=5$ Marks

(c) Write short notes on the following: Autoradiography and Freeze – Fracture Electron Microscope.

(i) Autoradiography.

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$3\times\frac{1}{2}=1\frac{1}{2}$ Marks

(iii) Freeze – Fracture Electron Microscope.

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$3\times\frac{1}{2}=1\frac{1}{2}$ Marks

(d) Write down progressively **Six** steps in reporting an experiment during a practical Biology class.

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$6\times\frac{1}{2}=3$ Marks

APPENDIX ONE
THE METRIC SYSTEM

The metric system of measurement is used by scientists throughout the world. It is based on units of ten. Each unit is ten times larger or ten times smaller than the next unit. The most commonly used units of the metric system are given below.

Commonly Used Metric Units

Length: The distance from one point to another

Meter (m) A meter is slightly longer than a yard. 1 meter (m) = 39.37 inches
1 meter = 1000 millimeters (mm) 1 yard (yd) = 36.00 inches
1 meter = 100 centimeters (cm) 1 inch (in) = 2.54 centimetres
(cm)
1000 meters = 1 kilometer (km)

Volume: The amount of space an object takes up

litre (L) A litre is slightly more than a quart
1 litre = 1000 millimeters (ml)
1 litre = 100 centilitres (cl)
1 litre = 10 decilitres (dl)

Mass: The amount of matter in an object

Gram (g) A paper clip has a mass equal to about one gram.
1000 grams = 1 kilogram (kg)

Temperature: The measure of hotness or coldness

Degrees 0C = freezing point of water
Celsius (C) 100C = boiling point of water

Metric English Equivalents

2.4 centimetres (cm) = 1 inch (in.)
1 metre (m) = 39.37 inches (in.)
1 kilometre (km) = 0.62 miles (mi)
1 litre (L) = 1.06 quart (qt)
236 milliliters (mL) = 1 cup (c)
1 kilogram (kg) = 2.2 pounds (1b)
1 hectare (ha), = 1,000 square metres (m^2)

Measures of Area

1 square kilometer (Km) = 100 hectares (ha)
1 hectare (ha) = 2.471 acres (ac)
1 acre (ac) = 0.4047 hectares (ha)
1 square metre (m^2) = 100 square centimetres (cm^2)

Table 1: Metric System and Prefixes in Use

Prefix	Multiple	Decimal Equivalent
Mega (M)	10^6	1,000,000
Kilo (K)	10^3	1,000
Deca (Da)	10^1	10
Deci (d)	10^{-1}	0.1
Centi (C)	10^{-2}	0.01
Milli (m)	10^{-3}	0.001
Micro ()	10^{-6}	0.000001
Nano (n)	10^{-9}	0.000000001

APPENDIX TWO
ADVANCED STUDY QUESTIONS ON CELLULAR ORGANIZATION

1.(a) In the study of cells, what are the limitations of (i), the light microscope and (ii) the electron microscope?

(b) Show the structure of the cell membrane (plasmalemma) by means of a fully-labeled diagram

(c) Describe the functions of the various chemical components of the cell membrane

(d) Distinguish between pinocytosis and phagocytosis. Describe examples of each in living cells.

NEAB June 1993, Paper IB, No. 4

2.(a) Describe the structure of

(i) The cell wall, and

(ii) The cell membrane in plant cells.

Include in your answer the arrangement of the chemical constituents and explain how they affect the functions of the two structures.

(b) Discuss the role and distribution of membranes in

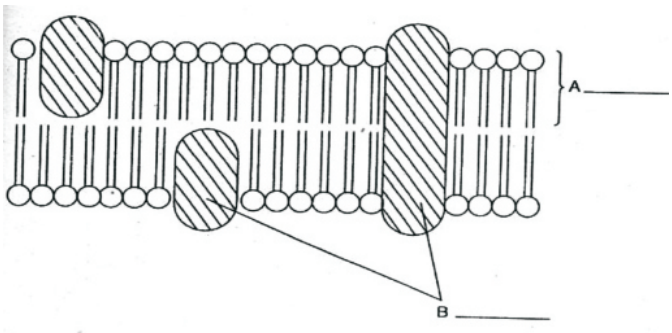
(i) Mitochondria,

(ii) Endoplasmic reticulum,

(iii) Nucleus.

NEAB June 1993, Paper IB, No. 6

3. The diagram shows a fluid mosaic model of a cell membrane



(a) Label the molecules A and B on the diagram

(b) Why is the model described as being fluid?

(c) Give two functions in the membrane of the molecules labeled B.

AEB June 1990, Paper 1, No. 8

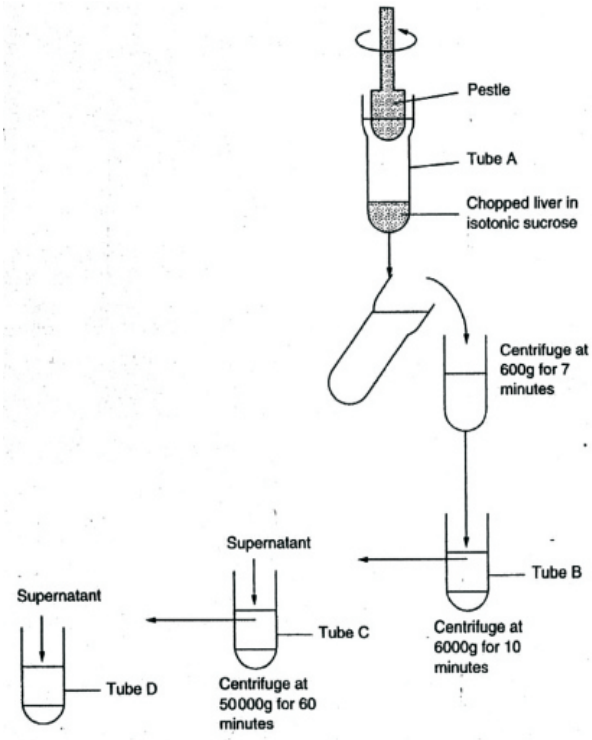
4. The table below refers to a bacterial cell, a liver cell and a palisade mesophyll cell and structures which may be found in them.

If the feature is present, place a tick (✓) in the appropriate box and if the feature is absent, place a cross (X) in the appropriate box.

Feature	Bacterial cell	Liver cell	Palisade cell
Nuclear envelope			
Cell wall			
Glycogen granules			
Microvilli			
Chloroplasts			

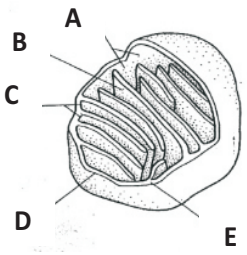
ULEAC June 1992, Paper 1, No. 8

5. The diagram below shows the stages involved in separating liver-cell components.



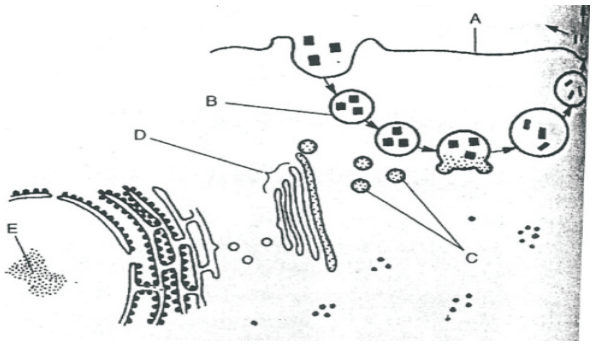
(a) Why is the tissue placed in an isotonic solution?
(b) The rotating pestle is lowered into Tube A. what is the purpose of this?
(c) The sediment in tube C would be rich in mitochondria. Give one way in which you could determine that this mitochondrial fraction was:
(i) pure
(ii) metabolically active
(d) Name one organelle that would be found in the sediment in Tube D.
AEB June 1992, Paper 1, No. 1

6 The figure below is a cutaway diagram of a mitochondrion from a liver cell



(a) Name the parts labeled **A,B,C,D,** and **E.**
(b) Suggest why liver cells contain large numbers of mitochondria
(c) (i) The matrix contains many hundreds of oxidative enzymes.
Name two substance which enter the mitochondria and are oxidized
(ii) Name three other substances which enter the mitochondria.
(d) Mitochondria contain DNA and ribosome. State the significance of their presence
(e) (i) Where does oxidative phosphorylation occur in mitochondria?
(ii) Explain briefly what is meant by oxidative phosphorylation
UCLES June 1992, Paper II, No. 1

2. he diagram below shows part of an animal cell and is based on a series of electron micrographs

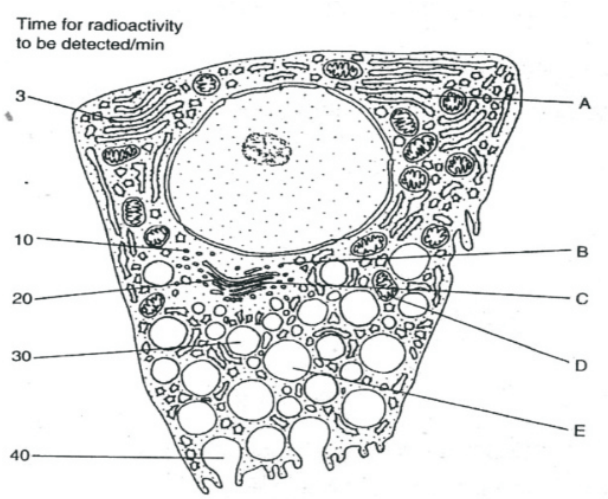


(a) (i) Name the structures labeled **A,B,C,D.**
(ii) Label with the letter F a structure where the protein contents of **D,** are synthesized.
(iii)What is the part played by **E** in the synthesis of this protein?
(iv) Describe two functions of **D** in cells of organisms
(b) (i) Name the process illustrated in the diagram which results in large particles entering the cell
(ii) This process is common in some types of white blood cell.
Suggest one reason why this cell activity is important to body
(iii)Name one group of organisms which feed using the process illustrated in the diagram.
WJEC June 1993, Paper A2

8 Outline the functions of each of the following cell organelles
(a) Golgi apparatus
(b) Microtubules
(c) Ribosomes
(d) Nucleolus
ULEAC June 1991, Paper 1, No. 6

9 (a) Outline the methods of preparation of sample of tissue for examination with the electron microscope. Explain why each stage in the preparation is necessary
(b) Explain briefly how an image of cell ultrastructure is formed by the electron microscope.
(c) Discuss the advantages and disadvantages of transmission electron microscope compared to light microscopy.
ULEAC June 1994, Paper 2, No. 6

10 Peptic cells from the lining of the mammalian stomach secrete the enzyme precursor pepsinogen. Some of these cells were isolated and maintained in a culture solution containing radioactively labeled amino acids. Samples of the cells were taken at regular intervals and prepared for electron microscopy. Below is a drawing from an electron micrograph of a peptic cell. The time taken for radioactivity to be detected in the various cell organelles viewed under the electron microscope is shown on the left of the drawing.



(a) Name the organelles **A** to **D.**
(b) Outline the sequence of events that result in the detection, at different times, of radioactivity in the organelles labeled **A** to **C.**
(c) Describe briefly the role of the nucleus in the synthesis of pepsinogen
(d) Suggest how the secretory material in the organelles labeled **E** passes out of the cell.
(e) Explain why relatively large numbers of the organelle **D** are required in secretory cells.

APPENDIX THREE
ADVANCED STUDY QUESTION ON AUTOTROPHIC NUTRITION (PHOTOSYNTHESIS)

1. Investigations of photosynthesis have involved the use of isotopes, centrifugation and two-dimensional chromatograph.

(a) Describe, in outline only, the principles involved in the use of these techniques in such investigations.

(b) Explain how the use of each one of these techniques has increased our knowledge of photosynthesis.

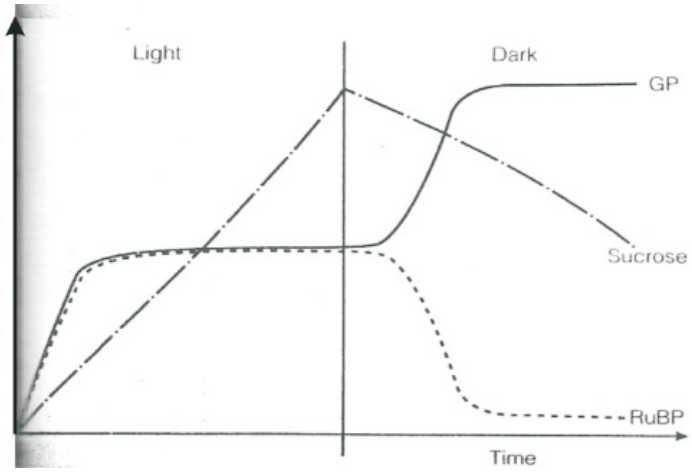
NEAB June 1990, Paper 1B, No. 4

2.(a) Describe fully the way in which energy is trapped by green plants and stored by means of the light stage of photosynthesis .

(b) Outline the ways in which the products of the light stage are directly and indirectly important for animals.

WJEC June 1993, Paper A1, No. 1

3. Algae were supplied with a radioactive isotope of carbon, 14C, and allowed to photosynthesize. After a period of time, the light was switched off and the algae left in the dark. The graph below shows the relative amounts of some radioactively labeled compounds over the period of the experiment.



Explain the changes in relative amounts of each of the following substances after the light was switched off:

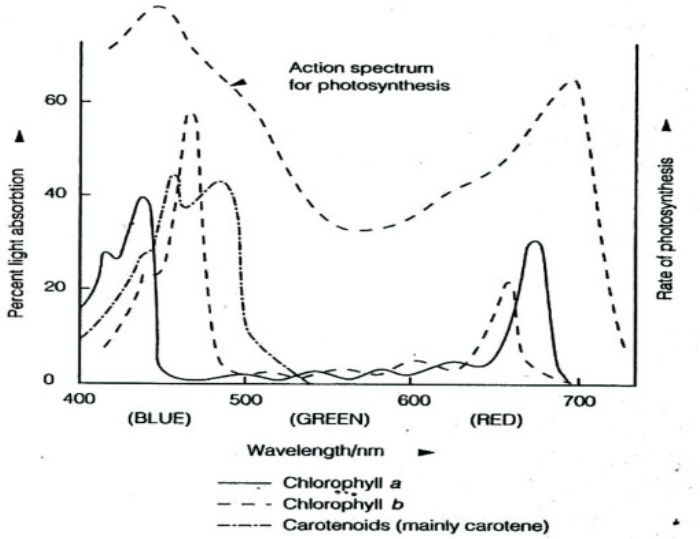
(a) Glycerate 3-phosphate, GP (phosphoglycerate, PGA);

(b) Ribolose bisphosphate (RuBP);

(c) Sucrose

AEB June 1991, Paper 1, No. 5.

4. The important pigments in most chloroplasts are the yellow-green chlorophyll a, the blue-green chlorophyll b and the orange carotenoids (mainly carotene). The diagram below shows (left y axis) the absorption spectra of these pigments.



(a) Using the information shown, state concisely one piece of evidence which suggests that absorption of white light by chloroplasts is not uniform over the whole spectrum.

(b) Which colour of light is best absorbed by the carotenoids?

(c) Why do most plants characteristically have a green colour?

(d) Chlorophyll a and chlorophyll b are almost identical molecules, both functioning in photosynthesis. How do the absorption spectra of the two differ?

(e) Variegated leaves have non-green, non-photosynthetic parts and such areas may appear pale yellow to dark yellow-orange. Suggest a reason for these facts with regard to energy absorption and utilization.

(f) The diagram also show (right y axis) the action spectrum for photosynthesis which is the amount of photosynthesis occurring in a green plant when illuminated by lights of different wavelengths (but of equal intensity).

(g) Suggest one suitable method of measuring and thus obtaining the experimental results necessary to produce the action spectrum graph.

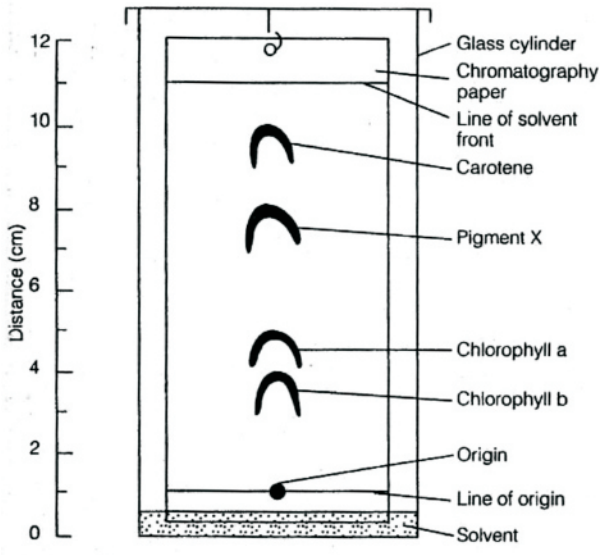
(h) Describe the relationship between the absorption spectrum and the action spectrum.

(i) Briefly indicate what role carotenoid pigments in plastids are thought to play in photosynthesis.

(j) If, in the laboratory, you wish to extract chlorophyll pigments you will need to use an organic solvent such as ether (ethoxyethane) or acetone (propanone). Such substances also dissolve lipids. Relate these two pieces of information to explain briefly why such a solvent is necessary in the extraction of the pigments.

Oxford June 1990, Paper 1, No. 9

5. (a) The technique of paper chromatography can be used to separate and identify different photosynthetic pigments.
Describe a method which could be used to prepare a solution of photosynthetic pigments from fresh geranium leaves.
(b) The diagram below shows the result of a chromatography experiment using the solution of photosynthetic pigments.



I. Describe the technique used to apply the pigment solution to the point of origin.

ii. Why has carotene a position closer to solvent front than the other pigments?

iii. The R_f value can be used to identify the different pigments.

$$\frac{\text{Distance travelled by pigment front from origin}}{\text{Distance travelled by solvent front from origin}}$$

iv. Name pigment X.

(c) It has been suggested that leaves of the copper beech have different photosynthetic pigments from those occurring in oak leafs.

SEB (revised) May 1991 Higher Grade, Paper No.

6. An investigation was carried out into the effect of carbon dioxide concentration and light intensity on productivity of lettuces in a glasshouse. The productivity was determined by measuring the rate of carbon dioxide fixation in milligrams per dm^2 leaf per hour Experiments were conducted at three different light intensities, 0.05, 0.25 and 0.45 (arbitrary units), approximating to full sunlight. A constant temperature of 22^0C was maintained throughout.

The results are given in the table below

ULEAC June 1992, Paper 1, No. 12

(a) For the experiment at 0.25 units light intensity, describe and comment on the effect on the productivity of the lettuces of increasing carbon dioxide concentration in the range
(i) 300 to 900ppm
(ii) 900 to 1300

(b) (i) A carbon dioxide concentration of 300ppm is approximately equivalent to that in atmosphere air.
For each of the three light intensities, work out the maximum increase in productivity that was obtained compared with that at 300ppm and use it to calculate the percentage increase in productivity at each light intensity.

1 At 0.05 units light intensity
2 At 0.25 units light intensity
3 At 0.45 units light intensity

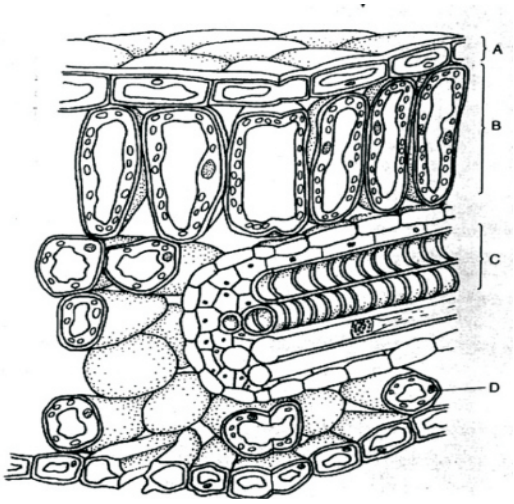
(ii) Comment on the effect on productivity of changing light intensity

(c) Explain why the carbon dioxide concentration affects the productivity of plants.

(d) State why the temperature should be kept constant during this experiment.

(e) Suggest why, even with artificial lighting, glasshouse crops generally need to have more carbon dioxide added when temperatures are low, than when temperatures are high

7. The diagram below shows part of a leaf



(a) (i) Name the cells A, B, and C

(ii) Name a structure present in cell B but absent from cell A.

(b) Describe how water moves from C into D and then into an air space.

(c) Name two substances which diffuse out through stomata in the light

(d) State two ways in which the shape of cell B is adapted for its functions in a leaf.

London January 1990, Paper 1, No. 1

8. Read through the following account of photosynthesis, then write on the dotted lines the most appropriate word or words to complete the account.

Photosynthesis is a type of ……..nutrition, involving the synthesis of organic molecules from inorganic materials. The process involves two types of reactions, light-dependent and light-independent.

In the light-dependent reactions, light energy is absorbed by chlorophyll molecules located on the …….. of the chloroplasts; ……. and …….. are produced and oxygen gas is given off a by-product.

In the light-independent reactions, …….accepts molecules of carbon dioxide, which together with the products of the light-dependent reactions, results in the formation of ……. . This compound can be converted to ……. or used to regenerate the carbon dioxide acceptor molecule.

ULEAC June 1993, Paper 1, No. 8

9. Summary

This question is about photosynthesis. You are asked to recall information about both the 'light' and the 'dark' reactions of photosynthesis. There is a short passage comparing the 'dark' reactions of cacti with plants with which you should be familiar. There are questions concerning the differences in the photosynthetic reactions found between these plants, and concerning the adaptations of cacti to dry conditions. Finally you are asked to comment on the biological problems associated with the destruction of tropical rain forests.

Section A

(a)(i) Draw a labeled diagram of a longitudinal section through an angiosperm chloroplast, indicating typical overall dimensions.

(ii) State the location in the chloroplast of the following processes:

1. Photoactivation of chlorophyll,
2. Regeneration of ribulose bisphosphate

(b)(i) Explain what is meant by the photo-activation of chlorophyll.

(ii) Describe how, as a consequence of the photoactivation of chlorophyll, both A T P and $NADPH_2$ may be formed in the chloroplast.

(iii) What is the third major chemical product of the light dependent reactions of photosynthesis?

Section B

In most plants of temperate zones the first stable intermediate of CO_2 fixation is a 3-carbon compound for this reason such plants are termed C3 plants. This fixation of CO_2 in these plants, although sometimes described as a 'dark' reaction, rapidly comes to a half in dark conditions.

In many cactus plants, whose stomata are open only at night, the mechanism of CO_2 fixation is different. Incoming CO_2 is attached to a 3-carbon compound by a cytoplasmic enzyme and a 4-carbon compound, malate, is formed. Malate is stored in the cell vacuole until daylight. It is then decomposed releasing CO_2 which enters the chloroplasts; here it is fixed by the mechanism normally used by C3 plants.

(a) Outline the formation of the first stable intermediate of CO_2 fixation in the dark reactions of C3 plants.

(b) Explain why the fixation of atmospheric CO_2 cannot proceed.

(i) During the day in a cactus plants and

(ii) At night in a C3 plant

(c) Using information in the passage above, state FOUR differences, apart from timing, between the processes of CO_2 fixation in C3 plants and cacti

(d) The pattern of stomatal opening and closing is an adaptation to life in a hot, dry environment. Suggest FOUR additional adaptations of cacti.

(e) The large scale destruction of rain forests in the South America is giving biologists cause for concern. Suggest FOUR adverse biological consequences of this destruction.

NISEAC June 1992, Paper III, No.3

10. An electron micrograph of parts of three chloroplasts in neighbouring cells of a maize leaf is shown.

(a)(i) Identify features, A,B,C,D,E and F.

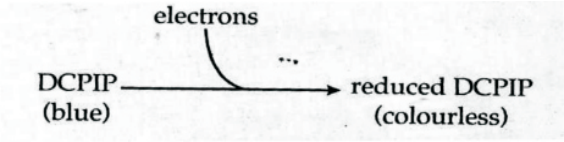
(ii) State briefly the functions of features E and F.

(iii) Which feature is the site of the light-independent stage of photosynthesis?

(b) The appearance of the large chloroplast shows that the leaf has been kept in the dark. How can you tell this?

(c) Feature G contains triglycerides. Give a simple diagram showing the structure of a triglyceride molecule.

The blue dye DCPIP can be converted to colourless reduced DCPIP by gaining electrons. This is summarized below.



A suspension of chloroplasts was made grinding fresh leaves in buffer solution and centrifuging the mixture. Tubes were then prepared and treated in the following way.

Tube	Contents	Treatment	Colour	
			At start	After 20 minutes
A	1cm^3 chloroplast suspension 5cm^3 DCPIP	Illuminated strongly	Blue/green	Green
B	5cm^3 DCPIP 1cm^3 buffer solution	Illuminated strongly	Blue	Blue
C	1cm^3 chloroplast suspension 5cm^3 DCPIP	Left in the dark	Blue/green	Blue/green

(d) (i) In tube A, from where do the electrons come that reduce the DCPIP?
(ii) What normally happens to these electrons in a photosynthesizing leaf?

(e) The chloroplast suspension may be contaminated with mitochondria. Explain the evidence from this investigation that the presence of mitochondria was not responsible for the reduction of the DCPIP.

(f) Name the carbon dioxide acceptor in the light-independent stage of photosynthesis.

AEB Summer 1994 (AS), Paper 1, No. 13

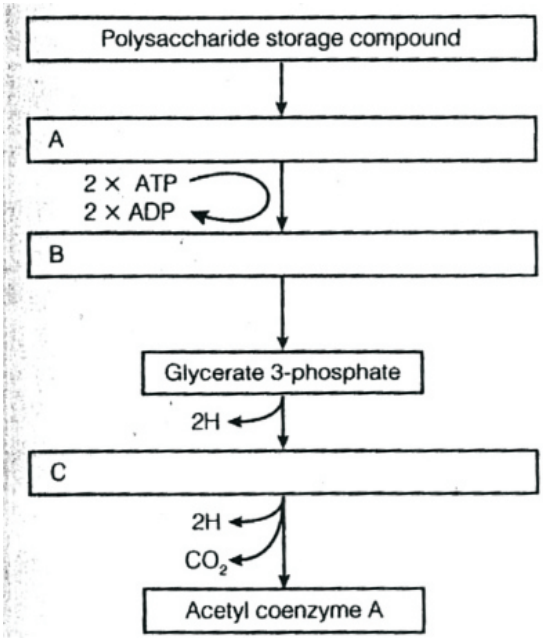
5. Succinate dehydrogenase is an enzyme in the Krebs (TCA) cycle which converts succinate into fumarate by dehydrogenation.
Two experiments were carried out investigating the changes in oxygen concentration in a suspension of isolated liver mitochondria, by placing the suspension in a reaction chamber containing an electrode which measured changes in oxygen concentration. In both experiments, A and B, the mitochondria were kept in a buffer solution containing sucrose and inorganic salts. In experiments B, succinate, a Krebs cycle intermediate, was included, and malonate was added 6 minutes after the experiment had begun. Malonate is a competitive inhibitor of succinate dehydrogenation.
The results are shown in the table below

Time/ Minute	**Oxygen Concentration/ Percentage Saturation**	
	Experiment A	**Experiment B**
0	100	100
2	97	89
4	94	78
6	92	66 (malonate added)
8	89	61
10	86	57
12	83	53

(a) Plot these data in a suitable form on graph paper
(b) Explain why the oxygen concentration decreased in both experiments.
(c) Compare the rates of oxygen utilization in experiments A and B during the first six minutes of the experiment and suggest and explanation for any differences you observe
(d) Explain why, in experiment B, the rate of oxygen consumption changed after the addition of malonate.

ULEAC January 1994, Paper 1, No.11

6.The diagram below shows stages in cellular respiration



(a) Write the name of one missing compound into each of the boxes A, B and C.
(b) (i) What is the name given to the series of reactions from A to C?
(ii) Where do these reactions occur in a eukaryotic cell?
(a) What happen to the hydrogen atoms removed during this process?
(b) Name one polysaccharide storage compound found in each of the following.
(i) Mammals
(ii) Flowering plants
ULEAC January 1994, Paper 1, No. 6

7.(a) (i) What is meant R.Q. (respiratory quotient)?
(ii) If the R.Q. of tissue X=1, of tissue Y=0.7, and of tissue Z=2.8, what can y o u conclude about respiration occurring in tissues X, Y and Z?
(b) (i) Describe the method and results of a practical experiment thatyou have performed in the laboratory to measure quantitatively the respiration rate of some plant or animal material.
(ii) State clearly two important precautions necessary to consider in order to achieve valid results in the experiment you have described in (b)
(c) Explain the significance of the following in the process of aerobic respiration:
(i) The use of ATP (adenosine triphosphate) in glycolysis,
(ii) Acetyl CoA,
(iii) NAD (nicotinamide adenine dinucleotide),
(iv) Cytochromes,
(v) Oxygen.
Oxford, June 1992, Paper II, No. 7

APPENDIX FOUR
ADVANCED STUDY QUESTIONS ON CELLULAR RESPIRATION

1.(a) Outline the process of anaerobic respiration in cells

(b) (i) Discuss the possible advantages and disadvantages of anaerobic respiration in yeasts and humans.

(ii) Explain the economic importance of anaerobic respiration in yeasts.

UCLES (Modular) June 1993, (Energy in living organisms), No. 1

2.(a) Make a labeled diagram to show the structure of the organelle in which the Krebs cycle and electron transfer occur. Indicate on the diagram where each of these processes takes place.

(b) (i) Describe the roles in the operation of the Krebs cycle and the electrons transport system of

(A) Coenzyme A,

(B) NAD,

(C) Cytochromes,

(D) Oxygen,

(E) ADP.

(c) Explain the inhibition of the Krebs cycle and the electron transfer system which occurs when there is a limited supply of

(i) Oxygen,

(ii) ADP or inorganic phosphate.

NEAB June 1993, Paper IB, No.6

3. In the process of glycolysis, the formation of pyruvate involves the chemical reaction:

$NAD^+ + 2H = NADP + H^+$

What happens to the NADH in

(a) An animal cell which in respiring aerobically

(b) A yeast cell which is respiring anaerobically

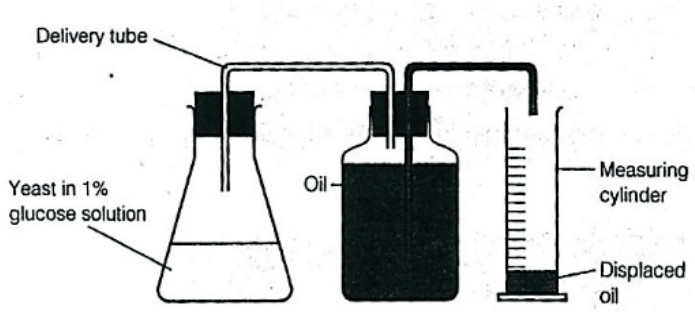
AEB June 1991, Paper 1, No. 8

4. Read through the following account of cellular respiration, and then write on the dotted lines the most appropriate word or words to complete the account.

This initial phase in the breakdown of glucose, a process known as ……., takes place in the ……. Of the cell and eventually results in the production of two molecules of …….from each molecule of glucose. In most organisms, this product then enters the second phase of cellular respiration, known as ……..cycle. This cycle occurs under……condition in specific organelles, called the ……During both phases, hydrogen atoms are removed from the substrate and passed to coenzymes such as ……. These reactions are catalyzed by enzymes called …… In the respiratory process, energy is released and used to synthesize energy rich molecules of ……from …….. and ……., thereby storing energy for future use.

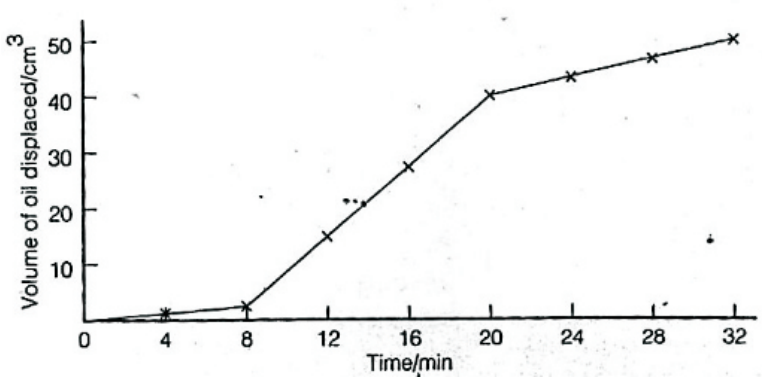
ULEAC June 1991, Paper 1, No.

8. The apparatus shown was used in an experiment to investigate the respiratory metabolism of yeast.



(a) Suggest why a smaller amount would be displaced if water were used instead of oil

Using this apparatus the results shown in the graph were obtained. Yeast was added at time 0.



(b) Suggest one explanation, in each case, for the rate of carbon dioxide production (volume of oil displaced)

(i) during the first 8 minutes;
(ii) between 8 and 20 minutes;
(iii) between 20 and 32 minutes.

(c) Predict what would happen to the shape of the graph if the experiment had been continued beyond 32 minutes. Give a reason for your prediction.

In a separate experiment, the ability for the yeast to metabolize a range of different carbohydrates, all at the same concentration, was investigated. The results obtained after 20 minutes are given in the table overleaf.

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CHAPTER GLOSSARY

CHAPTER ONE

Activation Energy: Energy needed to get a reaction started.

Adhesion: Attraction between molecules of different substances; attraction between unlike molecules.

Anomalous Expansion of water: Is an abnormal property of water whereby it expands instead of contracting when the temperature goes from 4^{o} C to O^{o} C, and it becomes less dense.

Biological catalyst orbiocatalyst: These are proteinaceous substances that are capable of catalyzing chemical reactions in biological systems without themselves undergoing any change.

Biomolecule also called biological molecule: Numerous substances that are produced by cells of living organisms.Involved in the maintenance and metabolic processes. Biomolecules have a wide range of sizes and structures and perform a vast array of functions. The four major types of biomolecules are carbohydrates, lipids, nucleic acids, and proteins.

Biosynthesis: Is the formation of natural products biomolecules through enzymatic reactions, as in cellular metabolism. Successive enzymatic reactions by a number of enzymes are generally required to achieve a single biological active compound.

Buckminsterfullerene: Is a type of fullerene with the formular C_{60}. It has a cage-like fused-ring structure that resembles a football, it is made of twenty hexagons and twelve pentagons. Each carbon atom has three bonds. It is a black solid that dissolves in hydrocarbon solvents to produce a violent solution.

Carbohydrate: A simple sugar or a polymer composed of sugar units, and used universally by cells for energy and as structural materials. A monosaccharide, oligosaccharide, or polysaccharide are examples

Carbon's versatility: Carbon is versatile because it can form single, double and triple bonds. It can also form chains branched chains, and rings when connected to other carbon atoms.

Cellular respiration: Process that releases energy by breaking down glucose and other food molecules.

Cofactor: One or more non-protein components required by enzymes in order to function; many cofactors are metal ions, while others are called coenzymes.

Cohesion: The binding together of like molecules, often by hydrogen bonds. Attraction between molecules of the same substance.

Condensation: A reaction in which two or more molecules react with elimination of water or some other simple substances, e.g. $2CH_3COOH$ $(CH_3CO)_2O + H_2O$.

Cytochrome: An iron-containing haemprotein, that form part of electron transport chains in mitochondria and chloroplasts.

Deoxyribonucleic acid (DNA): Double-helical molecule that carries the hereditary information of the cell.

Dipole: A pair of equal and oppositely charged or magnetized poles separated by a distance.

Disaccharide: A carbohydrate form of two simple sugar molecules linked by a covalent bond; sucrose is an example.A double sugar, consisting of two monosaccharides joined by dehydration synthesis.

Enzyme: An enzyme is a biological catalyst that speeds up the rate of a specific chemical reaction in the cell. The enzyme is not destroyed during the reaction and is used over and over.

Fatty acid: An organic compound consisting of a hydro carbon chain and terminal carboxylic group. Fatty acids vary in length and in the number and location of double bonds; three fatty acids linked to form a glycerol molecule form fat.

Germination: Early growth stage of a plant embryo.Initial stages in the growth of a seed to form a seedling.

Glycerol: A three-carbon molecule with three hydroxyl groups attached; glycerol molecules combine with fatty acids to form fats or oils. It is one of the end-products of fat/oil digestion.

Glycosidic bond: A glycosidic bond or glycosidic linkage is a type of covalent bond that joins a carbohydrate molecule to another group, which may or may not be another carbohydrate. A glycosidic bond is formed between the hemiacetal or hemiketal group of a saccharide and the hydroxyl group of some compound such as an alcohol.

Growth Factors: Growth factors are organic compounds such as amino acids, purines, pyrimidines and vitamins that a cell must have for growth but cannot synthesize by itself. Organisms having complex nutritional requirements and needing many growth factors are said to be fastidious.

Heat Capacity: Heat capacity or thermal capacity is a physical property of matter, defined as the amount of heat to be supplied to an object to produce a unit change in its temperature. The SI unit of heat capacity is joule per kelvin.

Hyponitrite reductase: This is enzyme that belongs to the family of oxidoreductases, specifically those acting on other nitrogenous compounds as donors with NAD+ or NADP+ as acceptor.

Lipid: One of a large variety of nonpolar organic molecules that are insoluble in water (which is polar) but dissolve readily in nonpolar organic solvents; lipids include fats, oils, steriods, phospholipids, and carotenoids.

Macromolecule: A macromolecule is a very large molecule important in biophysical processes, such as a protein or nucleic acid. It is composed of thousands of covalently bonded atoms. Many macromolecules are polymers of smaller molecules called monomers.

Molisch's test: Molisch's test is a sensitive chemical test, named after Austrian botanist Hans Molisch, for the presence of carbohydrates, based on the dehydration of the carbohydrate by sulfuric acid or hydrochloric acid to produce an aldehyde, which condenses with two molecules of a phenol, resulting in a violet ring.

Monosaccharaide: A simple sugar, such as five-carbon and six-carbon sugars, that cannot be dissociated into smaller sugar units.

MonounsaturatedFat: Monounsaturated fat is a type of dietary fat. It is one of the healthy fats, along with polyunsaturated fat. Monounsaturated fats are liquid at room temperature, but start to harden when chilled. Saturated fats and trans fats are solid at room temperature.

Nucleoside: A nucleosideis a glycosylamine that can be thought of as a nucleotide without a phosphate group. A nucleoside consists simply of a nucleobase and a five-carbon sugar whereas a nucleotide is composed of a nucleobase, a five-carbon sugar, and one or more phosphate groups.

Nucleotide: Nucleotideis an organic molecule consisting of a nucleoside and a phosphate. They serve as monomeric units of the nucleic acid polymers – deoxyribonucleic acid and ribonucleic acid, both of which are essential biomolecules within all life-forms on Earth.

Organic molecule: An organic molecule is a molecule that is made of carbon and hydrogen, and can include other elements. Organic molecules must contain carbon atoms covalently bonded to hydrogen atoms (C – H bonds). They usually involve oxygen and can also contain nitrogen, sulfur, phosphorus, and others.

Peptide bond: A covalent bond joining the alpha amino group of one amino acid to the carboxyl group of another with the loss of water molecule.

Phosphodiester bond: A phosphodiester bond occurs when two of the hydroxyl groups in phosphoric acid react with hydroxyl groups on other molecules to form two ester bonds. Phosphodiester bonds are central to all life on Earth,as they make up the backbone of the strands of nucleic acid.

Polarity: The property of a cell, or tissue or organism being structurally and or functionally different at opposite ends of its long axis.

Polysaccharide: Large macromolecule formed from monosaccharides.

Polyunsaturated Fat: Polyunsaturated fat is a type of dietary fat. It is one of the healthy fats, along with monounsaturated fat. Polyunsaturated fat is found in plant and animal foods such as salmon, vegetable oils, and some nuts and seeds.

Properties of Water: Water (H_2O) is a polar inorganic compound that is liquid at room temperature, tasteless and odorless, which is nearly colorless apart from an inherent hint of blue. It is by far the most studied chemical compound and is described as the "universal solvent" and the "solvent of life".

Purification of enzyme: Enzyme purification starts with removing the target enzyme from the host cells. Then, the isolated enzyme is decontaminated in a series of purification steps so that it is free from other cellular components and non-targeted enzymes.

Radicals: A radical is an atom, molecule, or ion that has at least one unpaired valence electron. With some exceptions, these unpaired electrons make radicals chemically reactive. Many radicals spontaneously dimerize. Most organic radicals have short lifetimes.

Ribonucleic acid (RNA): Single stranded helical molecule that carries the hereditary information of the cell.

Schiff's base: A Schiff base is a compound and considered as subclass of imines, being either secondary aldehydes or secondary ketimines depending on their structure. The term is commonly used as a synonym to azomethine (which refers to secondary aldimines).

Specificity: Uniqueness, of given organisms or enzymes in given reactions.

Surface Tension: A measure of how difficult it is to stretch or break the surface of a liquid.

Water has a high surface tension because of the hydrogen bonding of surface molecules.

Tetrahedral configuration: configuration of a compound in which four atoms or groups situated at the corners of a tetrahedron are linked (by covalent or coordinate bonds) to an atom at the centre of the tetrahedron.

Tetravalence: Tetravalence is the state of an atom with four electrons available for covalent chemical bonding in its valence. An example is methane: the tetravalent carbon atom forms a covalent bond with four hydrogen atoms. The carbon atom is called tetravalent because it forms 4 covalent bonds.

Turgor Pressure: The pressure exerted within the cell as a result of movement of water into the cell.
Universal Solvent: Water is a universal solvent because it is capable of dissolving more substances than any other liquid. This is important to every living thing on earth. It means that wherever water goes, either through the air, the ground, or through our bodies, it takes along valuable chemicals, minerals, and nutrients in solution.
Unsaturated: Not saturated: such as. a: capable of absorbing or dissolving more of something an unsaturated solution. b: able to form products by chemical addition especially, containing double or triple bonds between carbon atoms unsaturated fats.
Viscosity: Property of a fluid that resists the force within the fluid that causes it to flow.
Vitamins: A vitamin is an organic molecule that is an essential micronutrient that an organism needs in small quantities for the proper functioning of its metabolism. Essential nutrients cannot be synthesized in the organism, either at all or not in sufficient quantities, and therefore must be obtained through the diet.
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CHAPTER TWO

Acetabularia: Acetabularia is a genus of green algae in the family Polyphysaceae, Typically found in subtropical waters, Acetabularia is a single-celled organism, but gigantic in size and complex in form, making it an excellent model organism for studying cell biology.
Actin: A protein found in combination with myosin in muscle, an important component of cytoskeleton of many eukaryotes.
Adipose tissue: Adipose tissue is commonly known as body fat. It is found all over the body. It can be found under the skin (subcutaneous fat), packed around internal organs (visceral fat), between muscles, within bone marrow and in breast tissue.
Amoeboid Motion: Type of locomotion used by *amoebas*.
Apical Meristem: A young cell at the growing tip of a shoot or root.
Autotroph: Organism that is able to build the entire organic molecule it requires from inorganic sources chiefly carbon dioxide and nitrates from the physical environment. Photosynthetic autotrophs use sunlight energy; chemosynthetic autotrophs use energy from chemical reactions involving inorganic substances.
Axon: A typical long outgrowth, or process, from a neuron that carries nerve impulses away from the cell body toward target cells.
Axon: A typical long outgrowth, or process, from a neuron that carries nerve impulses away from the cell body toward target cells.
Cellular machinery: The physical and chemical components of the cell that function together to carry out the different physiological function of the cell.
Colonial Cell: A colony of single-cell organisms is known as colonial organisms. Many unicellular organisms can come together to make a colony with each organisms having a specific duty or job that benefits the whole colony. The difference between a multicellular organism and a colonial organism is that the individual organism that form a colony or biofilm can, if separated, survives on their own, while cells from a multicellular organism (e.g., liver cells) cannot.
Cytogenetics: The study of inheritance in relation to the structure and function of cells.
Cytologist: A biologist who studies the structure and functions of cells.
Cytology: The study of cell structure and function.

Electron Microscope: An electron microscope is a microscope that uses a beam of accelerated electrons as a source of illumination.
Eukaryote: Organism with cells that have nuclei and membrane-bound organelles.
Features of a Cell: A cell consists of three parts: the cell membrane, the nucleus, and, between the two, the cytoplasm. Within the cytoplasm lie intricate arrangements of fine fibers and hundreds or even thousands of miniscule but distinct structures called organelles.
Filamentous Cell: Filamentous cellis a long, multi-nucleoid, formed when normal cells elongate and replicate their DNA, but do not separate or divide. This elongated cells act as if it is "normal" cell – it express genes normally and continue to synthesize flagella.
Herbaceous: Denoting or relating to herbs
Heterotroph: Organism that cannot synthesize its own organic compounds and must obtain them from organic sources, for example: animals, fungi, many protistans, and most bacteria are heterotrophs.
Hormone: Substance produced in one part of an organism that affects another part of the same organism.
Lymph: The colourless fluid, derived from interstitial fluid, in the lymphatic system of vertebrate animals.
Macrophage: Macrophageis a specialized cell involved in the detection, phagocytosis and destruction of bacteria and other harmful organisms. In addition, they can also present antigens to T cells and initiate inflammation by releasing molecules (known as cytokines) that activate other cells.
Magnification: Magnification is the process of enlarging the apparent size, not physical size, of an object. This enlargement is quantified by a calculated number called "magnification". When this number is less than one, it refers to a reduction in size, sometimes called minification or de-magnification.
Meristematic Tissues: Plant tissue found only in the tips of shoots and roots; responsible for plant growth.
Modern Cell Theory: Theory that cells are the basic structural, functional, and organizational units of both single-celled and multicellular organisms; cells divide and pass on hereditary information; and energy flows within cells.
Muscular Tissue: Muscle tissue is composed of cells that have the special ability to shorten or contract in order to produce movement of the body parts. The tissue is highly cellular and is well supplied with blood vessels. Skeletal muscle fibers are cylindrical, multinucleated, striated, and under voluntary control.
Myosin: Myosin are a superfamily of motor proteins best known for their roles in muscle contraction and in a wide range of other motility processes in eukaryotes. They are ATP-dependent and responsible for actin-based motility.
Nervous Tissue: Tissue that receives messages from the body's external and internal environment, analyzes the data, and directs response.
Organelle: A membrane-bound body in the cytoplasm of a cell; there are several kinds, each with a specific function (e.g. mitochondrion, chloroplast).
Organ: Structure composed of different tissues, such as root, stem, leaf, or flower parts. Group of tissues that work together to perform closely related function.
Osteocyte: Bone cell or mechanosensory cell of bone that play key role in the function and adaptation of bone.
Parathyrin: Is a hormone produced by parathyroid gland that helps the body store and use calcium.

Parathyroid gland: In vertebrates, endocrine gland embedded in the thyroid gland that secretes parathyroid hormone, which helps restore blood calcium levels.
Parenchyma: A plant tissue consisting of roughly spherical undifferentiated cells, frequently with air spaces between them. These cells are called "totipotent" cells.
Plasma: Straw-colored fluid that makes up about 55 percent of blood.
Platelet: Any of the cell fragments in mammalian blood that release substances necessary for clot formation.
Prokaryote: Single-celled organism that has no nucleus or other membrane-bound organelles; only bacteria and archaea are prokaryotes.
Protoplasm: Protoplasm comprised of the cytoplasm and nucleous of a cell. It is the living part of a cell that is surrounded by a plasma membrane.
Protoxylem: The first-formed elements of the primary xylem.
Resolution of Microscope: In microscopy, the term 'resolution' is used to describe the ability of a microscope to distinguish detail. In other words, this is the minimum distance at which two distinct points of a specimen can still be seen - either by the observer or the microscope camera - as separate entities.
Spontaneous generation: Spontaneous generation, the hypothetical process by which living organisms develop from nonliving matter; also, the archaic theory that utilized this process to explain the origin of life.
Synapse: Synapse, also called neuronal junction is the site of transmission of electric nerve impulses between two nerve cells (neurons) or between a neuron and a gland or muscle cell (effector). A synaptic connection between a neuron and a muscle cell is called a neuromuscular junction.
Thrombocyte: Thrombocyteis a pieces of very large cell in the bone marrow called megakaryocyte. They help form blood clots to slow or stop bleeding and to help wounds heal.
Thyroclacitonin: Thyrocalcitonin also known as calcitonin is a polypeptide hormone secreted by the parafollicular or C cells of the thyroid gland. It lowers the levels of calcium and phosphate in the blood and promotes the formation of bone.
Tissue: A group of similar cells organized into a structural and functional unit.
Tracheid: A type of water-conducting cell in the xylem which lacks perforations in the cell wall.
Vascular cambium: The vascular cambium is the main growth tissue in the stems and roots of many plants, specifically in dicots such as buttercups and oak trees, gymnosperms such as pine trees, as well as in certain other vascular plants.
Vascular Tissue: Plant tissue consisting of cells joined into tubes that transport water and nutrients throughout the plant body.
Vessel element: A vessel element or vessel member (also called trachea or xylem vessel) is one of the cell types found in xylem, the water conducting tissue of plants. Vessel elements are typically found in angiosperms (flowering plants) but absent in most gymnosperms such as conifers.
Xylem: Of vascular plants, a tissue that transport water and solutes through the plant body.

CHAPTER THREE

Archaea: Domain of unicellular prokaryotes that have rigid cell walls through, but not of the same chemical composition like the peptidoglycan of bacteria.they grow in extreme environments in which most organisms cannot survive

Asparagine: Asparagine is a non-essential amino acid in humans derived from aspartic acid and plays an important role in the biosynthesis of glycoproteins and other proteins. Asparagine also helps in breaking down toxic ammonia within the cell in human.

Autotrophic bacteria: Autotrophic bacteria synthesize their own food. They derive energy from light or chemical reactions. They utilize simple inorganic compounds like carbon dioxide, water, hydrogen sulfide, etc., and convert them into organic compounds like carbohydrates and proteins, to supplement their energy requirements.

Bacterium: A prokaryotic organisms possessing rigid cell wall made up of peptidoglycan.

Cellular organization: Cellular organization can be defined as the components that make up a cell and how they are arranged within the cell. Each component called an organelle performs a specific function vital for the cell.

Centriole: A small cylinder of triplet microtubules near the nucleus in most animal cells. Centrioles occur in pairs; some give rise to the micro tubular core of flagella and cilia, and some may govern the plane of cell division. One of two tiny structures located in the cytoplasm of animal cells near the nuclear envelope.

Chromosome: A body consisting of a linear sequence of genes the hereditary factor and composed of nucleic acid, found in cell nuclei and appear in contracted form during mitosis and meiosis. They are present in constant number in each species. In man they are 46 in each cell.

Conjugation: Form of sexual reproduction in which organisms like paramecia and some prokaryotes exchange genetic information.

Cytoskeleton: The structural framework of a cell made up of microtubules, actin filaments, and intermediate filaments. This structure gives the cell its shape and helps organize the cell's parts. In addition, they provide a basis for movement and cell division.

Escherichia coli: *Escherichia coli*, also known as *E. coli* is a Gram-negative, facultative anaerobic, rod-shaped, coliform bacterium that is commonly found in the lower intestine of warm-blooded animals.

Eukaryotes: A cell that has a membrane-bounded nucleus, membrane-bounded organelles, and chromosomes in which the DNA is associated with proteins; an organism composed of such cells. Plants, animals, fungi, and protists are the four kingdoms of eukaryotes.

Facultative anaerobe: Bacteria that can grow in either the presence or absence of oxygen. In addition to oxygen concentration, the oxygen reduction potential of the growth medium influences bacterial growth.

Flagella: Fine threadlike structures protruding from a motile unicellular organism or the motile cells produced by multicellular organisms. Function primarily in locomotion.

Genetic Engineering: The introduction, by artificial means, of genes from one form of DNA into another form of DNA. The techniques involved in altering the characteristics of an organisms by inserting genes from another organisms into its DNA.

Genetic Material: Genetic material is the hereditary substance in the cell that carries all information specific to an organism. It is known as DNA (deoxyribonucleic acid) or RNA (ribonucleic acid).

Helical molecule: Double helix,is used to describe the physical structure of DNA. A DNA molecule is made up of two linked strands that wind around each other to resemble a twisted ladder in a helix-like shape. Each strand has a backbone made of alternating sugar (deoxyribose) and phosphate groups

Hydrocarbon: An organic compound that consists only of hydrogen and carbon atoms.

Hydrothermal Vent: A fissure in the ocean crust in the vicinity of spreading centers or subduction zones (places on Earth where two tectonic plates move away or towards one another),where cold seawater is heated by hot magma and reemerges to form the vents. Seawater in hydrothermal vents may reach temperatures of over 700° Fahrenheit.

Lactobacillus: Lactobacillus is a genus of Gram-positive, aerotolerant anaerobes or microaerophilic, rod-shaped, non-spore-forming bacteria. Comprised over 260 phylogenetically, ecologically, and metabolically diverse species.

Macronutrient: Essential nutrient needed in large amount by plants and animals.

Mesophile: A mesophile is an organism that grows best in moderate temperature, with a growth range from 20 to 45 °C. The optimum growth temperature for these organisms is 37°C. The term is mainly applied to microorganisms.

Mesosome: An organelle of bacteria that appears as an invagination of the plasma membrane and functions either in DNA replication and cell division or excretion of exoenzymes.

Metabolite: Intermediate substance made or used when the body breaks down food, drugs or chemicals, or its own tissue (for example, fat or muscle tissue).

Microaerophile: A microaerophile is a microorganism that requires environments containing lower levels of dioxygen than that are present in the atmosphere (i.e. < 21% O_2; typically 2–10% O_2) for optimal growth. A more restrictive interpretation requires the microorganism to be obligate in this requirement.

Micronutrient: Inorganic chemical elements required only in very small, or trace, amounts for growth, such as iron, chlorine, copper, manganese, zinc, molybdenum, nickel, and boron.

Mitochondria: Structures within the cytoplasm of eukaryotic cells that carry out aerobic respiration, it is the site of the Krebs cycle and electron transport chain and therefore the cell's energy production.

Monotrichous: Having a single flagellum at one pole - used by bacteria.

Mycoplasma: A group of very small, bacteria-like microorganisms intermediate between viruses and bacteria. They lack cell wall, making them pliable and able to pass through the pores of filters that retain other bacteria.

Nucleoid: A region in prokaryotic cells, that contains the genetic material DNA and therefore controls activities of the cell.

Nutrition: The process of taking in food and using it for growth, metabolism, and repair. Nutritional stages are ingestion, digestion, absorption, transport, assimilation, and excretion.

Pathogenic Bacteria: Pathogenic bacteria are bacteria that cause disease. Most species of bacteria are harmless and are often beneficial but others can cause infectious diseases. The number of these pathogenic species in human is estimated to be fewer than a hundred.

Peptidoglycan: Peptidoglycan is a rigid envelope surrounding the cytoplasmic membrane of most bacterial species. It helps protect bacterial cells from environmental stress and helps preserve cell morphology throughout their life cycle.
Polyribosomes: Aggregate of ribosomes, apparently concerned with protein synthesis as a group.
Psychrophilic Bacteria: Psychrophiles or cryophiles are extremophilic organisms that are capable of growth and reproduction at low temperatures, ranging from - 20 °C to +10 °C. They are found in places that are permanently cold, such as the Polar Regions and the deep sea.
Ribosome: A cell organelle constructed in the nucleolus, consisting of two subunits and functioning as the site of protein synthesis in the cytoplasm.
Spirilla: A long coiled or spiral bacterium.
Stromatolite: Rock made of banded domes of sediment in which are found the most ancient forms of life: prokaryote dating back as far as 3.5 billion years.
Tetracocci: A spherical bacterium occurring in square groups of four.
Thermophile: An organism with an optimal growth temperature between 45 and 80°C.
Transduction: Virus induced transfer of DNA from one bacterial cell to another. In generalized transduction, recombination occurs between genetic materials from two cells without selective transfer, whereas in specialized transduction, selective transfer occurs from DNA located near the integration site of the prophage.
Transformation: A phenomenon in which external genetic material is assimilated by a cell. Naked DNA from one organisms taken up by another and becoming expressed and integrated.
Viability: Viability is the ability to maintain itself or recover its potentialities.

CHAPTER FOUR

Acrophozoic: Having an extreme or irrational fear of heights.
Algae: Traditional term for a series of unrelated groups of photosynthetic eukaryotic organisms lacking multicellular sex organs (except for the charophytes); the "blue-green", or cyanobacteria, are one of the groups of photosynthetic bacteria.
Analogous: Applied to structures similar in function but different in evolutionary origin, such as the phyllodes of an Australian *Acacia* and the leaves of an oak.
Antibiotic: Natural organic substances formed by microorganisms that prevent growth of other microorganisms.
Blue-green Mold: Also called green mold. Any fungus of the genus Penicillium, which forms a bluish-green, furry coating on foodstuffs inoculated by its spores.
Brown Alga (Phaeophyte): The brown algae are large group of multicellular algae, including many seaweedsfound in colder waters within the northern hemisphere, and in marine environments, where they play an important role both as food and as a potential habitat.
Bud: An embryonic shoot, often protected by young leaves; or a vegetative outgrowth of yeast and some bacteria as a means of asexual reproduction.
Chemoheterotrophe: An organism that use organic molecules as a source of both for energy and carbon.

Chytrid: Any of the simple, algaelike fungi constituting the class Chytridiomycetes, order chytridiales, of aquatic and soil environments, having flagellated zoospores and little or no mycelium.
Ciliate: A **Ciliate** is a protozoans characterized by the presence of hair-like organelles called cilia, which are identical in structure to eukaryotic flagella, but are in general shorter and present in much larger numbers, with a different undulating pattern than flagella. Cilia occur in all ciliates and are variously used in swimming, crawling, attachment, feeding, and sensation.
Coenocyte: A mass of cytoplasm surrounding many nuclei and enclosed by a cell wall. It is found in certain algae and fungi.
Cyanobacteria: The early phototrophs that oxygenated the atmosphere; also known as blue-green algae.
Cyst: Cyst is a structure with a protective membrane or thickened wall, in protozoan that survive outside the host usually more resistant than the vegetative cell.
Cytosome: Cytosome (Plural cytosomes) (Biology, uncountable) the cytoplasm within a cell; the cell outside of the nucleus. Quotations (biology, countable) A type of cellular organelle which is enclosed by a membrane. Part of a cell specialized for phagocytosis. They appear as microtubule – supported funnel or groove where food is directed and sealed into vacuole.
Decomposers: Organisms (e.g. bacterium, fungus) that breaks down complex organic material to simple forms capable of being recycled.
Diatoms: A diatoms is a photosynthesizing alga; with siliceous skeleton (frustule), found in almost every aquatic environment including fresh and marine waters, soils, in fact almost anywhere moist. Diatoms are formally classified as belonging to the Division Chrysophyta, Class Bacillariophyceae.
Dinoflagellate: The dinoflagellateis a single-celled eukaryote constituting the phylum Dinoflagellata and usually considered algae. Dinoflagellates are mostly marine plankton, but they also are common in freshwater habitats. Their populations vary with sea surface temperature, salinity, and depth.
Euglenophyte: Euglenophyteis one of the best-known flagellates. A member of the protist phylum euglenophyta.They are commonly found in freshwater, especially when it is rich in organic materials, with a few marine and endosymbiotic members.
Eukaryote: Eukaryotes is any organism whose cell contains a nucleus and other membrane-bound organelles. There is a wide range of eukaryotic organisms, including all animals, plants, fungi, and protists, as well as most algae. Eukaryotes may be either single-celled or multicellular.
Filamentous algae: Filamentous algae are colonies of microscopic plant that link together to form threads or meshlike filaments. These primitive plants normally grow on the surface of hard objects or other substrates under the water but they can break loose and form floating mats. Examples include Spirogyra, Anabaena, Oscillatoria, Lyngbya, Pithophora spp. etc.
Flagellated: A flagellate pertains to any cell or organism that has one or more flagella. Certain organisms are flagellated in certain stages of their life cycle. The flagellum is one of the locomotory organelles that many single-celled eukaryotes utilize to propel themselves in an aquatic medium.
Flagellate: A flagellate is a cell or organism with one or more whip-like appendages called flagella. The word flagellate also describes a particular construction characteristic of many prokaryotes and eukaryotes and their means of motion.

Fly amanita:*Amanita muscaria*, commonly known as the fly amanita, is a basidiomycete of the genus Amanita. It is also called amanita mushroom.
Foraminiferan: Foraminifera are single-celled organisms, members of a phylum or class of amoeboid protists characterized by streaming granular ectoplasm for catching food and other uses; and commonly an external shell of diverse forms and materials.
Fragmentation: A mechanism of asexual reproduction in which the parent plants or animal breaks and separates into parts that reform whole organisms.
Fungal cell: Fungal cell is of few basic morphological types such as those with true hyphae (multicellular filamentous fungi) or the yeasts (unicellular fungi), or those which form pseudohyphae. A fungal cell has a true nucleus, internal cell structure and a cell wall.
Fungi: Kingdom composed of heterotrophs, many obtaining energy and nutrients from dead organic matter.
Gamete: A sex cell, one of two cells that unite to form a zygote.
Gametophyte: A gametophyte is one of the two alternating multicellular phases in the life cycles of some plants and algae. It is a haploid multicellular organism that develops from a haploid spore that has one set of chromosomes. The gametophyte is the sexual phase in the life cycle of plants and algae.
Gametophytic generation: Represents the sexual phase of the plant life. This cycle is named alternation of generations and organisms alternate between a sexual phase, or gametophyte generation and an asexual phase, or sporophyte generation.
Green Algae (Chlorophyte): The green algae are a large, informal grouping of algae consisting of the Chlorophyta and Charophyta/Streptophyta, which are now placed in separate divisions, together with the more basal Mesostigmatophyceae, Chlorokybophyceae and Spirotaenia.
Haustorium: A specialized structure of certain parasitic plants and fungi that penetrates the cells of the host plant to absorb nutrients. In parasitic fungi haustoria are formed from enlarged hyphae and in parasitic plants (cuscuta), they are stem outgrowths. A rootlike structure that grows into or around another structure to absorb water or nutrients. For example, in mistletoe or members of the broomrape family, the structure penetrates the host's tissue and draws nutrients from it.
Heterotrophic bacteria: Heterotrophic bacteria are those that derive energy from organic compounds. They are widely distributed and most abundant forms. They may be aerobic or anaerobic, and are omnipresent, found in air, food, soil, water. They help in recycling of natural substances.
Hyphae: Tubular filament of a fungus, oomycete, or chytrid; the hyphae together comprise the mycelium.
Lichen: An organism formed by the symbiotic association between a fungus and a photosynthetic alga.
Lysosomal enzyme: Lysosomal enzyme is synthesized in the endoplasmic reticulum (ER), transported to the Golgi apparatus, and are tagged lysosomes by the addition of mannose-6-phosphate label.
Macronucleus: A macronucleus is the larger type of a nucleus that undergo direct division without mitosis. It controls the non-reproductive cell functions, such as metabolism. During conjugation, the macronucleus disintegrates, and a new macronucleus is formed by karyogamy of the micronuclei.
Micronuclei: Micronuclei are extra-nuclear bodies that contain damaged chromosome fragments and/or whole chromosomes that are not incorporated into the nucleus after cell division. They can be induced by defects in the cell repair machinery and accumulation of DNA damages and chromosomal aberrations.

Microtubules: An unbranched tube-like proteinaeous structure commonly found inside the plasma membrane where it apparently regulates the addition of cellulose to the cell wall.
Monoploid: Less common term for haploid.The number of chromosomes in gametes.
Multinucleate: Multinucleate (multinucleated or polynuclear) is a eukaryotic cell that have more than one nucleus per cell, i.e., multiple nuclei share one common cytoplasm.
Mushroom: A sexually initiated phase in the life cycle of a club fungus, usually consisting of an expanded carp and a stalk (stipe).
Mutualistic relationship: The relation between two different species of organisms that are interdependent; each gains benefit from the other. Symbiosis, interdependence, interdependency, mutuality - a reciprocal relation between interdependent entities (objects or individuals or groups).
Mycelium: Mycelium is a structure of a fungus consisting of a mass of branching, thread-like hyphae. Fungal colonies composed of mycelium are found in and on soil and many other substrates.
Mycorrhizae: A symbiotic arrangement between fungal hyphae and young roots of many vascular plants, in which the fungus obtains carbohydrates from the plant and in turn releases, dissolved mineral ions to the plant roots.
Phagocytosis: A type of endocytosis involving large, particulate substances. Engulfment of foreign cells or substances by *amoebas* and some white blood cells, by means of endocytosis. Process in which extensions of cytoplasm surround and engulf large particles and take them into the cell.
Photoautotrophic: Organisms that uses energy from sunlight to convert carbon dioxide and water to carbon compounds.
Photosynthesis: The process whereby plant convert light energy to chemical energy; the production of carbohydrates from carbon dioxide and water in the presence of chlorophyll by using light energy.
Phycology: is the scientific study of algae, also known as **algology**.Phycology includes the study of prokaryotic forms known as blue-green algae or cyanobacteria..
Phytophthora: ***Phytophthora*** is a genus of plant-damaging oomycetes (water molds), whose member species are capable of causing enormous economic losses on crops worldwide, as well as environmental damage in natural ecosystems. The cell wall of *Phytophthora* is made up of cellulose. The genus was first described by Heinrich Anton de Bary in 1875. Approximately 170 species have been described, although 100–500 undiscovered *Phytophthora* species are estimated to exist.
Mushroompoisonous: Mushroom poisoning refers to a severe and often deadly effect of various toxins that are found in certain types of mushrooms. One type of mushroom known as *Amanita phalloides*, appropriately called "death cap," accounts for the majority of cases.
Predator: An organism that kill and feeds on other living organisms (its prey); unlike parasites, predators do not live on or in their prey. This act is called predation.
Proteinaceous thread: Consisting of or containing protein.
Protozoa: Phyla of protists consisting of non-photosynthetic protists that engulf or absorb their food.
Radiolarian: A single-celled aquatic animal that has a spherical Amoeba-like body with a spiny skeleton of silica. Their skeletons can accumulate as a slimy deposit on the seabed.
***Saccharomycescerevisiae*:** *Saccharomyces cerevisiae* is a type of budding yeast, capable of fermenting sugar into carbon dioxide and alcohol and is commonly used in the baking and brewing industries.

Saprobes: Heterotroph that obtains its nutrients from nonliving organic matter. Most fungi are saprobes.
Sarcodines: Sarcodina, the largest phylum of protozoans comprising the *amoebas* and related organisms; which are all solitary cells that move and capture food by means of pseudopods, flowing temporary extensions of the cell.
Septate: Divided by cross walls into partitions or compartments.
Slime mold: A simple organism that consists of an acellular mass of creeping gelatinous protoplasm containing nuclei, or a mass of amoeboid cells. When it reaches a certain size it forms a large number of spore cases.
Sporophytic generation: Sporophyte generation is that phase in the life cycle of certain plants that begins with the union of two single-celled haploid gametes. This union of haploid (n) gametes results in the formation of a single-celled diploid (2n) zygote. The zygote germinates and grows by going through a series of mitotic divisions.
Sporozoan: Any of the numerous protozoans of the phylum (or class) Sporozoa, generally characterized by being unicellular, non-motile, parasitic, and capable of reproducing sexually and asexually in alternate generations via spores.
Thylakoid: Thylakoidis a membrane-bound compartment inside chloroplasts and cyanobacteria. It is the site of the light-dependent reactions of photosynthesis. Thylakoids consist of a thylakoid membrane surrounding a thylakoid lumen.
Trichonympha: Trichonympha is a genus of single-celled, anaerobic parabasalids belonging to the order Hypermastigia, found exclusively in the hindgut of lower termites and wood roaches. Trichonympha's bell shape and thousands of flagella make it an easily recognizable cell.
Undolipadium: An undulipodium or a 9+2 organelle is a motile filamentous intracellular projection of eukaryotic cells. It is basically synonymous to flagella and cilia which are differing terms for similar molecular structures used on different types of cells, and usually correspond to different waveforms.
Water Mold: Parasitic or saprobic organisms living chiefly in fresh water or moist soil. Multinucleated organisms that superficially resemble fungi but are now recognized as having an independent evolutionary lineage and are placed in the kingdom protista.
Zoology: Zoology is the branch of biology that studies animals.The study include the structure, embryology, evolution, classification, habits, and distribution of all animals, both living and extinct, and how they interact with their ecosystems.
Zygospore: The thick-walled resting cell of certain fungi and algae, arising from the fusion of two similar gametes.
Zygote: The diploid product of the union of haploid gametes in conception; or after fertilization: Example fertilized egg.

CHAPTER FIVE

Adenovirus: Adenoviruses are medium-sized, non-enveloped viruses with an icosahedral nucleocapsid containing a double-stranded DNA genome. Their name derives from their initial isolation from human adenoids in 1953.
Allontois: This is a hollow sac-like structure filled with clear fluid that forms part of a developing amniote's conceptus (which consists of all embryonic and extra-embryonic tissues). It helps the embryo exchange gases and handles liquid waste.

Antibodies: One of a class of substances, natural or induced by exposure to an antigen, when have the capacity to react as agglutinins, lysins or precipitins with the specific or related antigens.

Bacteriophage: A bacteriophage is a type of virus that infects bacteria. The world "bacteriophage" literally means "bacteria eater" because bacteriophages destroy their bacterial host cells. All bacteriophages are composed of a nucleic acid molecule that is surrounded by a protein structure.

Cancer: Disorder in which some abnormal body's own cells lose the ability to control growth, by dividing uncontrollably, destroying body tissues.

Capsomer: The capsomere is a subunit of the capsid, an outer covering of protein that protects the genetic material of a virus. Capsomeres self-assemble to form the capsid. Subunits called protomers aggregate to form capsomeres. Various arrangements of capsomeres are: 1 Icosahedral, 2 Helical, and 3 Complex.

Crystalized: To cause to form crystals or assume crystalline form.

Endemic disease: A disease outbreak is endemic when it is consistently present but limited to a particular region. This makes the disease spread and rates predictable. Malaria, for example is considered endemic in certain countries and regions. Example West Africa.

Endocytosis: The uptake of material into cells by means of invagination of the plasma membrane; if solid material is involved, the process is called phagocytosis; if dissolved material is involved, it is called pinocytosis.

Enveloped virus: Virus that has an outer covering or wrapping is called enveloped virus. The envelope comes from infected cell or host. Envelope may help a virus survive and infect other cells.

Epidemic: Disease that occurs in an unusually high number of individuals in a population at the same time.

Exocytosis: The cellular secretion of macromolecules by the fusion of vesicles with the plasma membrane, aiding the release of contents outside the cell.

Genome: The totality of genetic material(information) contained in the nucleus, plastid or mitochondria of an organisms.

Infectivity: Is the ability of a pathogen to establish an infection. The measure of infectivity in a population is called incidence. A pathogen's infectivity is subtly but importantly different from its transmissibility, which refers to a pathogen's capacity to pass from one organism to another.

Intermediate Host: An organism in or on which a parasite develops to an adult but not sexually mature stage.

Intracellular virus: Viruses are small, obligate intracellular containing either a RNA or DNA genome surrounded by a protective, virus-coded protein coat.

Latency: The state of existing but not yet being developed or manifest; concealment.

Lysis of cell: The disintegration of a cell by rupture of the cell wall or membrane.

Lysogenic Cycle: A type of viral replication cycle in which the viral genome becomes incorporated into the bacterial host chromosome as a prophage.

Lytic: Relating to or causing lysis.

Metabolism: All those chemical reactions by which cells acquire and use energy as they synthesize, accumulate, break apart, and eliminate substances in ways that contribute to growth, maintenance and reproduction.

Mosaic virus: A mosaic virus is any virus that causes infected plant foliage to have a mottled appearance. Such viruses come from a variety of unrelated lineages and consequently there is no taxon that unites all mosaic viruses.

Oncogenic: An **oncogene** is a gene that has the potential to cause cancer. In tumor cells, these genes are often mutated, or expressed at high levels.Causing development of tumor (cancer).

Paralysis: Complete or partial loss of muscle functions.

Parasitism: Relationship between two species of which one benefits at the expense of the other, sometimes without killing the host organism.

Polyhedral: A polyhedron is a three-dimensional shape with flat polygonal faces, straight edges and sharp corners or vertices. The word polyhedron comes from the Classical Greek as poly- + -hedron.

Prion: A prion is an infectious protein that has no nucleic acid. They are virus-like entity made up of a prion protein.

Retroviruse: A retrovirus is a virus that uses RNA as its genomic material. Upon infection with a retrovirus, a cell converts the retroviral RNA into DNA, which in turn is inserted into the DNA of the host cell. The cell then produces more retroviruses, which infect other cells.

Rotational Axis: Rotation around a fixed axis is a special case of rotational motion. The fixed-axis hypothesis excludes the possibility of an axis changing its orientation and cannot describe such phenomena as wobbling or precession.

Subcutaneous: The subcutaneous tissue, also known as the hypodermis or superficial fascia, is the layer of tissue that underlies the skin. The terms originate from subcutaneous in Latin and hypoderm in Greek, both of which mean "beneath the skin," as it is the deepest layer that rests just above the deep fascia.

Taxonomy: The branch of science concerned with classification, especially of organisms; systematics.

Transcription: The transfer of information from a DNA molecule into an RNA molecule.

Vaccination: Injection of a weakened or mild form of a pathogen to produce immunity.

Variolation: The old practice of inoculating someone with the virus of smallpox to produce immunity to the disease.

Viral Replication: Viral replication is the formation of biological viruses during the infection process in the target host cells. Through the generation of abundant copies of its genome and packaging these copies, the virus continues infecting new hosts.

Virion: A viral particle in its inert extracellular state. An entire virus particle, consisting of an outer protein shell called a capsid and an inner core of nucleic acid (either ribonucleic or deoxyribonucleic acid—RNA or DNA).

Viroid: A piece of RNA that does not have a protein coat but does replicate within living cells.

Virulence: Degree of pathogenicity of a pathogen.

Virus: A minute particle, in the range of 250 to 10 million, consisting of a core of nucleic acid, usually surrounded by a protein coat, incapable of growth alone and can reproduce only within and at the expense of a living cell.

CHAPTER SIX

Apoptosis: Programmed cell death.The process of cell death that occur naturally as part of the normal development, maintenance, and renewal of tissues within an organism.
Autolysis: The self-digestive process of dissolving cell walls and their breakdown during senescence. The process of self-destruction of a cell, cell organelle or tissue as a results of the release of lysosymes from lysosomes.
Basal Body: A self-reproducing, cylinder-shaped cytoplasmic organelle from which cilia or flagella arise, identical in structure to the centriole.
Cell membrane: Thin, flexible barrier around a cell; regulates what enters and leaves the cell.
Cell Wall: A rigid or semi-rigid supportive wall outside the plasma membrane; a cellular feature of plants, fungi, protistans, and most bacteria.
Chloroplasts: An organelle containing chlorophyll, found in cells of most photosynthetic organisms.
Cholesterol: A steroid forming an essential component of animal cell membranes and acting as a precursor molecule for the synthesis of other biologically important steroids.
Chromatin: The aggregate masses of dispersed genetical material form of DNA and protein and observed between periods of cell division in eukaryotic cells.
Cisternae: A flattened or saclike portion of the endoplasmic reticulum or a Golgi body (dictyosome).
Contractile vacuole:A clear, fluid-filled vacuole in some groups of protists that takes up water within the cell and then contracts, expelling its contents from the cell.
Cytochrome: Iron containing protein involved in molecule transfer in an electron transport system.
Cytoplasm: A general name for complex chemical matter of a cell encompassing the area between the cell membrane and the nucleus.
Cytoplasmic Matrix: This is the clear fluid part of the cytoplasm which can exist in two states, sol and gel. The two are respectively called plasmasol and plasmagel. Plasmagel is usually present below the plasma membrane.
Cytoskeleton: Network of protein a filament within some cells that helps the cell maintains its shape and is involved in many forms of cell movement.
Cytosol: Fluid, living part of a cell, in which organelles are distributed within it. The semi fluid portion of the cytoplasm.
D-amino acid oxidase: An enzyme that catalyzes the oxidative deamination of D-amino acid to the corresponding α-keto acids, producing ammonia and hydrogen peroxide.
Dictyosomes: These are complex of cisternae (tightly packed flattened sacs) and associated residues which together form the golgi apparatus. Itfunction in accumulating and packaging substances used in the synthesis of materials by the cell.
Electrolyte: Substance that dissociates into ions in aqueous solution and so make possible the conduction of an electric current through the solution.
Endocytosis: A process by which part of the plasma membrane encloses substances (or cells, in the case of phagocytes) at or near the cell surface, then pinches off to form a vesicle that transports the substance into the cytoplasm.
Endoplasmic Reticulum: An extensive membranous network in eukaryotic cells, continuous with the outer nuclear membrane and composed of ribosome-studded (rough) and ribosome-free (smooth) regions.
Etiolated leaf: A condition characterized by long internodes, poor leaf development, and pale, weak appearance due to a plant growing in partial or complete absence of light.

Eukaryotic cell: Eukaryotic cell is a cell containing organized nucleus and organelles which are enveloped by membrane-bound organelles. Examples of eukaryotic cells are plants, animals, protists, fungi.
Exocytosis: Process by which a cell remove materials from inside the cell into the extracellular fluid using vesicles.
Ferritin: Ferritin is a blood protein that contains iron. A universal intracellular protein that stores iron and releases it in controlled manner.
Flagella: Long cellular appendages specialized for locomotion, formed from a core of nine outer doublet microtubules and two inner single microtubules, ensheathed in an extension of plasma membrane.
Fluid-mosaic model: The fluid mosaic model describes the cell membrane as a tapestry of several types of molecules (phospholipids, cholesterols, and proteins) that are constantly moving. This movement helps the cell membrane maintain its role as a barrier between the inside and outside of the cell environments.
Gluconoegenesis: Gluconeogenesis refers to metabolic pathways that result in the synthesis of new glucose from noncarbohydrate precursors, to provide glucose when dietary intake is insufficient or absent. Gluconeogenesis occurs in liver and kidney. The precursors of gluconeogenesis are lactate, glycerol, amino acids, and with propionate making a minor contribution.
Glycolate pathway: Is one of the body's important metabolic pathways involving a sequence of enzymatic reactions that break down glucose (glycolysis) into pyruvate, creating the energy sources adenosine triphosphate (ATP) and nicotinamide adenine dinucleotide (NADH).
Glycoprotein: One of a group of conjugated proteins which upon decomposition yield a protein and carbohydrate or derivatives of same. Glycoproteins are proteins which contain oligosaccharide chains (glycans) covalently attached to amino acid side-chain. The carbohydrate is attached to the protein in a cotranslational or posttranslational modification. This process is known as glycosylation. Secreted extracellular proteins are often glycosylated.
Glyoxylate pathway: This is an anabolic pathway involving the converstion of acetyl-COA to succinate fot he synthesis of glucose. It occurs in plants, bacteria, protists and fungi.
Glyoxysome: Glyoxysome is a specialized peroxisome found in plants and also in filamentous fungi,which participated in the conversion of lipids to sugar during the early stages of germination in oil seeds. E.g. Corn, Soybean, Sunflower, Peanut and pumpkin. As in all peroxisomes, in glyoxysomes the fatty acids are oxidized to acetyl-CoA by peroxisomal β-oxidation enzymes.
Golgi Apparatus: Stack of membrane in the cell that modifies sorts, and packages proteins from the endoplasmic reticulum.A sepecialized and polarized portion of a smooth-surfaced endoplasmic reticulum.
Golgi network: The trans-golgi network (TGN) is a major secretory pathway sorting station that directs newly synthesized proteins to different subcellular destinations. The TGN also receives extracellular materials and recycled molecules from endocytic compartments.
Heamoglobin: Hemoglobin or haemoglobin, abbreviated Hb or Hgb, is the iron-containing oxygen-transport metalloprotein in the red blood cells of all vertebrates as well as the tissues of some invertebrates. Hemoglobin in blood carries oxygen from the lungs gills or skin to the rest of the body.

Hemicellulose: Hemicellulose can be defined as cell wall polysaccharides that have the capacity to bind strongly to cellulose micro fibrils by hydrogen bonds found in the cell walls of plnts.
Hydrolytic Enzyme: Hydrolytic enzyme alternatively referred to as hydrolase split different groups of biomolecules such as esters, peptides and glycosides into simpler units.
Hydrophobic tail: A nonpolar portion of a substance that is repelled by water molecules and so does not readily dissolve in water.
Hypocotyl: The portion of an embryo or seedling situated between the cotyledon and the radicle.
Inorganic substance: An inorganic compound is typically a chemical compound that lacks carbon–hydrogen bonds, that is, a compound that is not an organic compound. However, the distinction is not clearly defined; authorities have differing views on the subject.
Lignin: One of the most important constituents of the secondary wall of vascular plants, although not all secondary walls contain lignin; after cellulose, lignin is the most abundant plant polymer.
Lipase: Lipase is a family of enzymes that catalyzes the hydrolysis of fats. Some lipases display broad substrate scope including esters of cholesterol, phospholipids, and of lipid-soluble vitamins and sphingomyelinases; however, these are usually treated separately from "conventional" lipases.
Lipid: A lipidis any of a diverse group, of organic compounds, occurring in living organisms, that are insoluble in water but soluble in organic solvents, that contain hydrocarbon and their building block. Examples of lipids include fats, oils, waxes, certain vitamins (such as A, D, E and K), hormones and most of the cell membrane that is not made up of protein.
Lysosome: An organelle, bounded by a single membrane, and containing hydrolytic enzymes that are capable of breaking down proteins and other complex macromolecules.
Metamorphosis: Transformation of a larva into an adult form by way of major tissue reorganization.
Microbody: Microbody is different type of body present in the cytosol, also known as cytosome. A microbody is usually a vesicle with a spherical shape, ranging from 0.2-1.5 micrometers in diameter. Microbodies are found in the cytoplasm of a cell, but they are only visible with the use of an electron microscope.
Microfibril: A submicroscopic thread-like constituent of the cell wall; composed in most plants of cellulose molecules.
Microfilament: A solid rod of actin protein in the cytoplasm of almost all eukaryotic cells, making up part of the cytoskeleton and acting alone or with myosin to cause cell contraction.
Microtubule: A hollow rod of tubulin protein in the cytoplasm of all eukaryotic cells and in cilia, flagella, and the cytoskeleton.
Microvilli: Microvilli (singular: microvillus) are microscopic cellular membrane protrusions that increase the surface area for diffusion and minimize any increase in volume, and are involved in a wide variety of functions, including absorption, secretion, cellular adhesion, and mechanotransduction.
Middle lamella: The middle lamella is a layer that cements together the primary cell walls of two adjoining plant cells. It is the first formed layer to be deposited at the time of cytokinesis. The cell plate that is formed during cell division itself develops into middle lamella or lamellum.
Nucleoplasm: The substance of a cell nucleus, especially that not forming part of a nucleolus.
Nucleus: A specialized body within the eukaryotic cell bounded by a double membrane and containing the chromosomes.

Organic compound: Any of a large class of chemical compound in which one or more atoms of carbon are covalently linked to atoms of other elements, most commonly hydrogen, oxygen, or nitrogen. The few carbon-containing compounds not classified as organic include carbides, carbonates, and cyanides.
Osmoregulation: The control of water content and the concentration of salts in the body of an animal or protist or protozoan.
Pancreas: Glandular organ that secretes enzymes and bicarbonate into the small intestine during digestion, and that also secretes the hormones insulin and glucagon.
Pectins: A highly hydrophilic polysaccharide present in the intercellular layer and primary wall of plant cell walls.
Peroxisomes: Any of a group of subcellular particles, formed in the cytoplasm of many types of cells, that contain a variety of enzymes, especially relatively high proportion of catalase, D-amino acid oxidase and other oxidases.
Phagocytic vacuole: Phagocytes are cells that protect the body by ingesting harmful foreign particles, bacteria, and dead or dying cells. The professional phagocytes include many types of white blood cells (such as neutrophils, monocytes, macrophages, mast cells, and dendritic cells).
Phospholipid: one of a group of lipids having both a phosphate group and one or more fatty acids.Important components of cellular membranes.
Photorespiration: A special respiratory process in many higher plants in which there is uptake of oxygen in the presence of light and giving out of carbon-dioxide contrary to the general pattern of photosynthesis. The oxygenase activity of Rubisco combined with the salvage pathway, consuming O_2 and releasing CO_2; occurs when Rubisco binds O_2 instead of CO_2.
Pinocytosis: A type of endocytosis in which the cell ingests extracellular fluid and its dissolved solutes.
Plastid: Organelle in the cells of certain groups of eukaryotes that is the site of such activities as food manufacture and storage; apart from nucleus, plastid are the largest solid inclusion in the plant cell.
Polysome: Several ribosomes all translating the same messenger RNA molecule.
Spherosome: Sphaerosome or oleosomeis a small cell organelle bounded by a single membrane which take part in storage and synthesis of lipids. These were first observed by Hanstein but discovered by Perner. Term sphaerosomes was given by Dangeard.
Steroid: Any of a group of lipids derived from a saturated compound called cyclopentanopenhydrophenanthrene.A lipid with a backbone of four carbon rings. Steroids differ in the number and location of double bonds in the backbone and in the number, position, and type of functional groups.
Storage Granule: Storage granule is a membrane-bounded vesicle containing condensed materials. They include zymogen granules and condensing vacuoles. These granules are the parts of the cell that store the cell's energy reserves as well as other important metabolites.
Tannin: Tannin is biomolecules that bind to and precipitate proteins and various other organic compounds including collagen, amino acids and alkaloids. The term tannins refer to the use of oak and other bark in tanning animal hides into leather. Tannin is commonly found in leaves, unripe fruits and bark of trees.

Turgidity: Turgidity is the state of being swollen, especially due to high fluid content. In general context, turgidity refers to the condition of being bloated, distended, or swollen.
Vacuole: A membrane-enclosed sac taking up most of the interior of a mature plant cell and containing a variety of substances air, water or other liquid, sap, or food particles important in pant reproduction, growth, and development.

CHAPTER SEVEN

Alkaline medium: Describing a situation that has an excess of hydroxide ions i.e. a pH greater than 7.
Anabolic reaction: (Also, anabolism) pathways that require an input of energy in the form of ATP to synthesize complex molecules like proteins, fats and other constituents of living organisms from simpler ones.
Anabolism: The building up part of metabolism; the total chemical processes involved in the biosynthesis of proteins, fats and other constituents of living organisms.
Axiom: An **axiom** is a concept in logic. It is a statement which is assumed to be true without question, and which does not require proof. It is also known as a postulate (as in the parallel postulate). The axiom is to be used as the premise or starting point for further reasoning or arguments, usually in logic or in mathematics.
Biological processes: Biological processes are those processes that are vital for an organism to live, and that shape its capacities for interacting with its environment. Biological processes are made of many chemical reactions or other events that are involved in the persistence and transformation of life forms.
Catabolic reactions: it involves the breakdown of large, organic molecules into, simpler ones, accompanied by release of energy. The other type of metabolic reaction, anabolism, involves the building of complex, organic molecules from smaller components and requires an input of energy.
Catabolism: Collectivity, the chemical reactions resulting in the breakdown of complex materials and involving the release of energy.
Catalase: Catalase is a common enzyme found in nearly all living organisms exposed to oxygen (such as bacteria, plants, and animals) which catalyzes the decomposition of hydrogen peroxide to water and oxygen. It is a very important enzyme in protecting the cell from oxidative damage by reactive oxygen species (ROS).
Catalyst: A substance that alters the rate at which a chemical reaction occurs but itself is being unchanged at the end of reaction.
Cholinesterase: Cholinesterase is an enzyme that helps nervous system work the way it should. Certain toxic chemicals in the environment can interfere with this enzyme and affect the nervous system. These chemicals include organophosphates and carbamates. They are most often found in insecticides used in agriculture.
Co-Enzyme: An organic molecule, or nonprotein organic cofactor, that plays an accessory role in enzyme-catalyzed processes, often by acting as a donor or acceptor of electrons; NAD^+ and FAD are common coenzymes.
Complex molecule: Complex organic molecules are molecules with multiple carbon atoms such as benzene and acetic acid.
Decomposition: To break down or be broken down into simpler parts or substances especially by the action of living things (as bacteria and fungi).

Dehydrogenase: An enzyme that catalysis the removal of hydrogen atoms from a molecule, particularly in the electron transport chain reactions of cell respiration in conjunction with the coenzymes NAD and FAD "glucose-6-phosphate dehydrogenase".
Denaturation: A process in which a protein unravels and loses its native conformation, thereby becoming biologically inactive. Denaturation occurs under extreme conditions of pH, salt concenration, and temperature.
Enzymatic ability: The ability of an enzyme to bind substrate in their active site and then chemically modify the bound substrate, converting it to a different molecule – (the product of the reaction).
Enzyme molecule: A class of protein serving as catalyst, chemical agents that change the rate of a reaction without being consumed by the reaction.
Enzyme product complex: A bound substrate is converted to product by catalytic groups in the active site, forming the enzyme-product complex (EP). The bound products are released, returning the enzyme to its unbound form, ready to catalyze another round of converting substrate to product.
Enzyme specificity: Enzyme specificity is a property of the enzyme and describes how restrictive the enzyme is in its choice of substrate; a completely specific enzyme would have only one substrate.
Enzyme: A class of protein serving as catalyst, chemical agents that change the rate of a reaction without being consumed by the reaction.
Holoenzyme: A complete enzyme including its prosthetic group and with full enzymatic activity.
Hydrolysis: A chemical process that lyse or split a molecule by the addition of water; an essential process in digestion. The breakdown of complex molecule to simple one as a result of the union of water with the compound; the process is usually controlled by enzymes. Splitting of one molecule into two by addition of the H^+ and OH^- ions of water.
Hydrophobic interaction: Hydrophobic interaction describe the relations between water and hydrophobes (low water-soluble molecules). Hydrophobes are nonpolar molecules and usually have a long chain of carbons that do not interact with water molecules. The mixing of fat and water is a good example of this particular interaction.
Inhibition: An inner impediment to free activity, expression, or functioning.
Inhibitor: A substance that reduces or suppresses the activity of another substance.
Intracellular enzyme: Intracellular enzyme or endoenzymeis a type of enzyme functioning inside the cell. They are responsible for undertaking millions of metabolic reactions inside the cell of both eukaryotes as well as prokaryotes.
Isomerase: Isomeraseis a general class of enzyme that convert a molecule from one isomer to another. Isomerase facilitates intramolecular rearrangements in which bonds are broken and formed. The general form of such a reaction is as follows: A–B $\rightarrow$ B–A. There is only one substrate yielding one product.
Ligation process: The act of tying a blood vessel or other tube in the body with a piece of thread or wire.
Lock and key hypothesis: The Lock and Key HypothesisBasically, substrates fit into an enzyme the way a key fits into a lock. If the substrate is not the correct shape, it won't fit into the enzyme, and no chemical reaction can occur. Only those substrates that exactly fit into the enzyme can be catalyzed.

Metabolic Pathway: A linear or cyclic series of breakdown or synthesis reactions in cells, the steps of which are catalyzed by the action of specific enzymes.
Neuro secretion: The secretion of neurohormones by neurosecretory cells. These neurohormones, produced by neurosecretory cells, are normally secreted from hypothalamus cells in the brain that then circulate into the blood. The pituitary responds to releasing hormones produced by the hypothalamus, when in this way indirectly controls hormone production in other glands.
Phosphorylation: The introduction of phosphate group (PO) to a biomolecule is a reaction that is normally controlled by a phosphorylase enzyme.
Polypeptide: A peptide comprising ten or more amino acids.
Prosthetic group: A tightly bound non-peptide inorganic or organic component of a protein. It may be lipid, carbohydrate, metal ion or phosphate group.
Ribonuclease: An enzyme present in various body tissues which depolymerizes ribonucleic acid.
Ribozyme: Any RNA molecule that can catalyse changes to its own molecular structure. Self-splicing introns are examples of ribozymes.
Substrate: The foundation to which an organism is attached; or the substance acted on by an enzyme.
Succinic Acid: Succinic acid is a dicarboxylic acid with the chemical formula $(CH_2)_2(CO_2H)_2$. The name derives from Latin succinum, meaning amber. As such, succinate links cellular metabolism, especially ATP formation, to the regulation of cellular function.
Variation: The differences that occur within the offspring of a particular species.

CHAPTER EIGHT

Abnormal haemoglobin: Hemoglobin abnormalities are the group of blood disorders that affect the normal functioning of the hemoglobin in the red blood cells. These are genetic disorders that results in the altered size and shape of the red blood cells, thereby decreasing the oxygen-carrying capacity of the blood. Abnormal heamoglobin results from mutations that change the sequence or number of nucleotides within the globin gene.
Adenine: A purine base present in DNA, RNA, and nucleotide derivatives, such as ADP and ADP.
Amino acid: An organic molecule possessing both carboxyl and amino groups. Amino acids serve as the monomers of protein.
Amino group: A functional group in a protein molecule that consists of a nitrogen atom bonded to two hydrogen atoms; it can act as base in solution, accepting a hydrogen ion and acquiring a charge of +1.
Anemia: A condition in which the blood doesn't have enough healthy red blood cells.
Anticodon: In a tRNA molecule, the three-nucleotide sequence that base-pairs with the mRNA codon for the amino acid carried by that particular tRNA; the anticodon is complementary to the mRNA codon.
Carbohydrate: Biological macromolecule in which the ratio of carbon to hydrogen and to oxygen is 1:2:1; carbohydrates serve as energy sources and structural support in cells and form the cellular exoskeleton of arthropods.
Codons: Is one of the series of base triplets in an mRNA molecule that code for a series of amino acids that will be strung together during protein synthesis. Different codons specify different amino acids; a few serve as a stop signal and one type as a start signal.

Complementary Base: Either of the two nitrogen containing sections of a nucleotide that bond together to connect strands of DNA or RNA, guanine is the complementary base of cytosine, and adenine is the complementary base of thymine in DNA and of uracil in RNA.
Complementary strands: Either of the two chains that make up a double helix of DNA, with corresponding positions on the two chains being composed of a pair of complementary bases. A section of one nucleic acid chain that is bonded to another by a sequence of base pairs.
Conjugated proteins: This is a protein that functions in interaction with other chemical groups attached by covalent bonding or weak interaction.
Cosmic ray: Cosmic rays are high-energy protons and atomic nuclei that move through space at nearly the speed of light. They originate from the sun, from outside of the solar system in our own galaxy, and from distant galaxies.
Cytosine: Cytosine is one of the four nucleobases found in DNA and RNA, along with adenine, guanine, and thymine. It is a pyrimidine derivative, with a heterocyclic aromatic ring and two substituents attached. The nucleoside of cytosine is cytidine.
Deoxyribonucleoside triphosphate: Deoxyribonucleoside triphosphate is the nucleoside triphosphate containing deoxyribose. They are the building blocks of DNA, and they lose two of the phosphate groups when incorporated into DNA during replication.
Deoxyribose sugar: Deoxyribose, or more precisely 2-deoxyribose, is a monosaccharide with idealized formula H-(C=O)- (CH_2)-$(CHOH)_3$-H. Its name indicates that it is a deoxy sugar, meaning that it is derived from the sugar ribose by loss of an oxygen atom. Deoxyribose is most notable for its presence in DNA.
Deoxyribose: A pentose sugar $C_5H_{10}O_4$ that is a structural element of DNA.
Dihyreuridine: Dihydrouridine is a pyrimidine nucleoside which is the result of adding two hydrogen atoms to uridine, making it a fully saturated pyrimidine ring with no remaining double bonds. It is found in tRNA and rRNA molecule as a nucleoside; the corresponding nucleobase is 5,6-dihydrouracil.
DNA Code: DNA code is a set of chemical rules used by living cells to translate information encoded within genetic material (DNA or mRNA sequences of nucleotide triplets, or codons) into proteins. These are made up of four chemical bases: adenine, guanine, cytosine and thymine.
DNA Replication: The process by which a DNA molecule makes an exact copy of itself.
Double helix: The form of native DNA, referring to its two adjacent polynucleotide strands wound into a spiral shape.
Evolution: The accumulation of genetic changes in populations of living organisms through many generations.The process by which different kinds of living organism are believed to have developed from earlier forms over time.
Gamma rays: Electromagnetic radiation of high energy and short wavelength entitled by nucleus of an atom when it has excess energy.
Gene: A gene is a basic unit of heredity and a sequence of nucleotides in DNA that encodes the synthesis of a gene product, either RNA or protein.
Geneticist: A geneticist is a biologist who studies genetics, the science of heredity, and variation of organisms.
Guanine: Guanine (G) is one of the four nucleotide bases in DNA. Within a double-stranded DNA molecule, guanine base on one strand pair with cytosine base on the opposite strand. The sequence of the four nucleotide bases encodes DNA information.

Hereditary information: Genes are units of hereditary information, which organisms pass down to new generations. Genes contain coded information for the production of proteins that enable cells to function.
Hydrogen bond: A hydrogen bond (or H-bond) is primarily electrostatic force of attraction between a hydrogen (H) atom which is covalently bound to a more electronegative "donor" atom or group, and another electronegative atom bearing a lone pair of electrons—the hydrogen bond acceptor (Ac).
Inosine: Inosine is a chemical that is found in tRNA, present in all living cells and essential for
Methyl group: A methyl group is an alkyl derived from methane, containing one carbon atom bonded to three hydrogen atoms, having chemical formula CH_3. In formulas, the group is often abbreviated as Me. This hydrocarbon group occurs in many organic compounds. It is a very stable group in most molecules.
Monomeric nucleotide: Nucleotides are organic molecules consisting of a nucleoside and a phosphate. They serve as monomeric units of the nucleic acid polymers – deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), both of which are essential biomolecules within all life-forms on Earth.
mRNA code: The three-letter nature of codons means that the four nucleotides found in mRNA — A, U, G, and C — can produce a total of 64 different combinations. Of these 64 codons, 61 represent amino acids, and the remaining three represent stop signals, which trigger the end of protein synthesis.
mRNA message: mRNA carries a "message" from the nucleus to the cytoplasm. The message is encoded in the nucleotide sequence of the mRNA, which is complementary to the nucleotide sequence of the DNA that served as a template for synthesizing the mRNA. Making proteins from mRNA is called translation
Mutation: An inheritable change in a gene or chromosome.
Nitrogen bases: A molecule that contains nitrogen and has the chemical properties of a base. The nitrogenous bases in DNA are adenine (A), guanine (G), thymine (T), and cytosine (C). The nitrogenous bases in RNA are the same, with one exception: adenine (A), guanine (G), uracil (U), and cytosine (C).
Normal haemoglobin concentration: The healthy range for hemoglobin is: For men, 13.2 to 16.6 grams per deciliter. For women, 11.6 to 15 grams per deciliter.
Nucleic Acid: Large polymeric molecules composed of repeating units of nucleotides linked by sugar-phosphate linkage, e.g. RNA (ribose nucleic acid) and DNA (deoxyribose nucleic acid).
Nucleoside: An organic molecule consisting of a nitrogenous base joined to a five-carbon sugar.
Nucleotide: A single unit of nucleic acid, composed of a phosphate, a five-carbon sugar (either ribose or deoxyribose), and a purine or a pyrimidine.
Peptide bond: A peptide bond is an amide type of covalent chemical bond linking two consecutive alpha-amino acids from C_1 of one alpha-amino acid and N_2 of another, along a peptide or protein chain.
Phosphate group: A phosphate group is just a phosphorus atom bound to four oxygen atoms. Along with sugars and bases, it makes up nucleic acids, like DNA and RNA. As part of energy carriers, like ATP, it provides energy for moving our muscles.
Polymer: A polymer is any of a class of natural or synthetic substance composed of very large molecules, called macromolecules, which are multiples of simpler chemical units called monomers.

Polypeptide product: A polypeptide is a chain of many amino acids. A protein contains one or more polypeptides. Therefore, proteins are polypeptide products of long chains of amino acids held together by peptide bonds.
Protein molecule: A protein molecule is made from a long chain of amino acids, each linked to its neighbor through a covalent peptide bond. Proteins are therefore also known as polypeptides. Each type of protein has a unique sequence of amino acids, exactly the same from one molecule to the next.
Protein synthesis: Protein synthesis is the process of creating protein molecules. In biological systems, it involves amino acid synthesis, transcription, translation, and post-translational events.
Protein: A proteinis a large biomolecule and macromolecule that comprise one or more long chains of amino acid residues
Purine: The larger of the two kinds of nucleotide bases found in DNA and RNA; a nitrogenous base with a double-ring structure, such as adenine or guanine.
Pyrimidine: The smaller of the two kinds of nucleotide bases found in DNA and RNA: a nitrogenous base with a single-ring structure.
Pyrimidine base: There are three pyrimidine bases found in nucleic acids: thymine (T), cytosine (C), and Uracil (U).
R group: An abbreviation for any group in which a carbon or hydrogen atom is attached to the rest of the molecule. Sometimes used more loosely, to include other elements such as halogens, oxygen, or nitrogen.
Ribose phosphate: Ribose 5-phosphate is both a product and an intermediate of the pentose phosphate pathway.
Thymine: Is one of the four nucleobases in the nucleic acid of DNA. The others are adenine, guanine, and cytosine. Thymine is also known as 5-methyluracil, a pyrimidine nucleobase. In RNA, thymine is replaced by the nucleobase uracil.
Transcription: Process in which part of the nucleotide sequence of DNA is copied into a complementary sequence in RNA. DNA – directed synthesis of messenger RNA.
Translation: The assembly of a protein on the ribosomes; mRNA is used to direct the order of the amino acids.The RNA-directed synthesis of protein.
Ultra violet rays: Ultraviolet (UV) radiation is a form of non-ionizing radiation that is emitted naturally by the sun and artificial sources. While it has some benefits for people, including the creation of Vitamin D, it also can cause health risks. Our natural source of UV is sun radiation.
Uracil: Nitrogen-containing base found in RNA molecuies; can base-pair with forces adenine.
Van der waals forces: Van der Waals forces include attraction and repulsions between atoms, molecules, and surfaces, as well as other intermolecular forces.

CHAPTER NINE

Alternation of Generation: The occurrence within the life cycle of an organism of two or more distinct forms (generation), which differ from each other in appearance, habitat and mode of reproduction. A reproductive cycle in which a haploid (*n*) phase, the gametophyte, produces gametes which, after fusion in pairs to form a zygote, germinate, producing a diploid (*2n*) phase, the sporophyte. Spores produced by meiotic division from the sporophyte give rise to new gametophytes, completing the cycle.

Anaphase: A stage in mitosis in which the chromatids of each chromosome separate and move to opposite poles; similar stage in meiosis in which chromatids or paired chromosomes move apart.
Bucleolar organizer: Nucleolus organizer regions are chromosomal regions crucial for the formation of the nucleolus. The specific part of a chromosome with which a nucleolus is associated especially during its reorganization after nuclear division.
Cell Cycle: A sequence of events by which a cell increases in mass, roughly doubles its number of cytoplasmic components, duplicates its DNA, then undergoes nuclear and cytoplasmic division. The cycle extends from the time the cell forms until its own daughter cells form.
Cell Division: The division of a parent cell and its contents, usually into two roughly equal parts. Process by which a cell divides into two new daughter cells.
Centromere: A small, constricted region of a chromosome having attachment sites for micro-tubules that help move the chromosome during nuclear division. The centralized region joining two sister chromatids.
Centromeric Structure: A specialized condensed region of each chromosome that appears during mitosis where the chromatids are held together to form an X shape.
Centrosome: Material present in the cytoplasm of all eukaryotic cells and important during cell division; also called microtubule organizing center.
Chiasma: The point at which paired homologous chromosomes remains in contact as they begin to separate during the first prophase of meiosis. The X-shaped, microscopically visible region representing homologous chromatids that have exchanged genetic material through crossing over during meiosis.
Chromatid: A chromatid is one of two identical halves of a replicated chromosome. Following DNA replication, the chromosome consists of two identical structures called sister chromatids, which are joined at the centromere.
Chromatin fibres: The aggregate mass of dispersed genetic material formed of DNA and protein and observed between periods of cell division in eukaryotic cells.
Chromosome replication: During every cell division, a cell must duplicate its chromosomal DNA through a process called DNA replication. The duplicated DNA is then segregated into two "daughter" cells that inherit the same genetic information. This process is called chromosome segregation.
Crossing over: It refers to the exchange of a portion of DNA between paired homologous chromosomes (one from each parent) that occurs during the development of egg and sperms cells (meiosis).
Cytokinesis: The actual splitting of a parental cell into two daughter cells; also called cytoplasmic division. The division of the cytoplasm to form two separate daughter cells immediately after mitosis.
Diakinesis: The fifth and last stage of the prophase of meiosis, following diplotene, when the separation of homologous chromosomes is complete and crossing over has occurred.
Diplonema: Diplonema is a genus of free living organisms in the Euglenozoa. They are distinguished from Rhynchopus in Class Diplonemea by the absence of a fully flagellate dispersive stage.
Diplotene: The fourth stage of the prophase of meiosis, following pachytene, during which the paired chromosomes begin to separate into two pairs of chromatids.
Dyads: Something that consists of two elements or parts.
Gametogenesis: Gametogenesis is the production of gametes from haploid precursor cells. In animals and higher plants, two morphologically distinct types of gametes are produced (male and female) via distinct differentiation programs.

Gametophyte generation: It represents the sexual phase of the plant life. This cycle is named alternation of generations and organisms alternate between a sexual phase, or gametophyte generation and an asexual phase, or sporophyte generation. The term gametophyte may refer to the gametophyte phase of the plant life cycle or to the particular plant body or organ that produces gametes.

Gametophyte phase: In the gametophyte phase, which is haploid (having a single set of chromosome), male and female organs (gametangia) develop and produce sperm and egg respectively (gametes) through simple mitosis for sexual reproduction.

Gametophyte: The haploid (n) gamete-producing phase of the life cycle of an organism that exhibits Alternation of Generations.

Gene expression: Gene expression is the process by which information from a gene is used in the synthesis of a functional gene product that enables it to produce end products, protein or non-coding RNA, and ultimately affect a phenotype, as the final effect.

Haploid cell: Haploid describes a cell that contains a single set of chromosomes. The term haploid can also refer to the number of chromosomes in egg or sperm cells, which are also called gametes. In humans, gametes are haploid cells that contain 23 chromosomes.

Homologous chromosomes: Homologous chromosomes are made up of chromosome pairs of approximately the same length, centromere position, and staining pattern, for genes with the same corresponding loci. One of the homologous chromosome is inherited from the organism's mother; the other is inherited from the organism's father.

Homologs: One of a pair of chromosomes that segregate from one another during the first meiotic division. A gene related to a second gene by descent from a common ancestral DNA sequence.

Hypothesis: A temporary working explanation or supposition based on accumulated facts and suggesting some general principle or relation of cause and effect; a postulated solution to a scientific problem that must be tested by experimentation and, if disproved or shown to be unlikely, is discarded.

Interphase: The period following the completion of cell division, when the nucleus is not dividing. During this period changes in both the nucleus and the cytoplasm result in the complete development of the daughter cells.

Karyokinesis: The series of changes that occur in the nucleus of a cell in the process of division.

Kinetochore: A kinetochore is a disc-shaped protein structure associated with duplicated chromatids in eukaryotic cells where the spindle fibers attach during cell division to pull sister chromatids apart

Macromolecular Synthesis: Macromolecules sysnthesis is the assembling of larger molecules, such as proteins during cell division. Macromolecules are composed of thousands of covalently bonded protein molecules. Many macromolecules are polymers of smaller moleules called monomers.

Meiosis: A two-stage type of cell division in sexually reproducing organisms that results in gametes with half the chromosome number of the original cell.

Metaphase plate: The metaphase plate is a plane or region that is approximately equidistant from the two poles of a dividing cell. In mitosis, for instance, the metaphase plate is apparent during metaphase. The formation of metaphase plate is in fact one of the indications that the cell is in metaphase

Metaphase: The stage of mitosis or meiosis during which the chromosomes lie in the equatorial plane of the spindle.
Microtubules: An unbranched tubelike proteinaeous structure commonly found inside the plasma membrane where it apparently regulates the addition of cellulose to the cell wall.
Mitosis stage: A process of cell division in eukaryotic cells conventionally divided into the growth period (interphase) and four stages: prophase, metaphase, anaphase, and telophase. The stages conserve chromosome number by equally allocating replicated chromosomes to each of the daughter cells.
Ploidy: The number of chromosomes occurring in the nucleus of a cell. In normal somatic (body) cells, the chromosomes exist in pairs. The condition is called diploidy. During meiosis the cell produces gametes, or germ cells, each containing half the normal or somatic number of chromosomes.
Progeny: A descendant or the descendants of a person, animal, or plant; offspring.
Prometaphase: Prometaphase is the second phase of mitosis, the process that separates the duplicated genetic material carried in the nucleus of a parent cell into two identical daughter cells. During prometaphase, the physical barrier that encloses the nucleus, called the nuclear envelope, breaks down.
Prophase: An early stage in nuclear division, characterized by the shortening and thickening of the chromosomes and their movement to the metaphase plate.
Sex Cell: A gamete isan organism's reproductive cell. It is also referred to as sex cells. Female gametes are called ova or egg cells, and male gametes are called sperm. Gametes are haploid cells, and each cell carries only one copy of each chromosome. These cells develop into sperm or ova.
Sister chromatid: A sister chromatid refers to the identical copies (chromatids) formed by the DNA replication of a chromosome, with both copies joined together by a common centromere. In other words, a sister chromatid may also be said to be 'one-half' of the duplicated chromosome. A pair of sister chromatids is called a dyad.
Somatic Cell: Relating to all the cells of an animal or plant other than the reproductive **cells;** all cells except the gametes and the cells from which the gametes develop.
Sporophyte phase: In the sporophyte phase a diploid (having two sets of chromosomes) plant body grows and eventually produces spores through meiosis. These spores divide mitotically to produce haploid (having a single set of chromosomes) gamete-producing bodies called gametophytes.
Sporophyte: The spore-bearing stage of those plants which alternate between asexual and sexual generations; in higher plants, the sporophyte generation is dominant.
Stages of Mitosis: Mitosis, a process of cell duplication, or reproduction, during which one cell gives rise to two genetically identical daughter cells. Strictly applied, the term mitosis is used to describe the duplication and distribution of chromosomes, the structures that carry the genetic information.
Synaptonemal complex: The synaptonemal complex (SC) is a protein lattice that resembles railroad tracks and connects paired homologous chromosomes in most meiotic systems. The two side rails of the SC, known as lateral elements (LEs), are connected by proteins known as transverse filaments.

Syngamy: Syngamy is the fusion of the male and female gametes to initiate the development of a zygote that will grow into a new individual organism. The cycle of fertilization and development of new individuals is called sexual reproduction.
Telophase: Final stage when chromosomes decondense into threadlike structures and two daughter nuclei form. Fourth and final phase of mitosis, during which the chromosomes begin to disperse into a tangle of dense material.
Triploid cell: Triploidy is a rare chromosomal abnormality. A cell that has three times (3n) the haploid number (n) of chromosomes.Triploidy is the presence of an additional set of chromosomes in the cell, for a total of 69 chromosomes rather than the normal 46 chromosomes per cell. The extra set of chromosomes originates either from the father or the mother during fertilization.

CHAPTER TEN

Absorptive Cell: The most common epithelial cell type lining the small intestine and colon lumen. These cells are optimized for nutrient absorption through the apical plasma membrane and nutrient export through the basal plasma membrane.
Adenosine triphosphate (ATP): One of the principal chemical compounds that living things use to store and release energy.
Angiosperms: A flowering plant, which forms seeds inside a protective chamber called the ovary.
Archae bacteria: Archaebacteria are a group of microorganisms considered to be an ancient form of life that evolved separately from the bacteria and blue-green algae, and they are sometimes classified as a kingdom.
Ascospores: A spore produced within an ascus; found in ascomycetes.
Basidiospores: Spore in basidiomycetes that germinate to produce haploid primary mycelia.
Biceps muscle: Is a muscle on the front part of the upper arm. The biceps has two heads that includes a "short head" (biceps brachii) and a "long head" (biceps femoris) that work as a single muscle. The biceps is attached to the arm bones by tough connective tissues called tendons.
Bilateral symmetry: Body plan in which only a single, imaginary line can divide the body into two equal halves; characteristic of worms, arthropods, and chordates.
Bioluminescence: Bioluminescence is the production and emission of light by living organisms. Bioluminescence occurs widely in marine vertebrates and invertebrates, as well as in some fungi, microorganisms including some bioluminescent bacteria, and terrestrial arthropods such as fireflies.
Body cavity: A body cavity is any space or compartment, or potential space, in an animal body. Cavities accommodate organs and other structures; cavities as potential spaces contain fluid.
Bryophyte: Nonvascular plant, for example mosses and their relatives.
Bryophyte: Nonvascular plant, for example mosses and their relatives.
Cephalochordate: A chordate without a backbone, represented by lancelets, tiny marine animals.
Chlorophyll pigment: Green pigment that captures light energy that drives the light reactions of photosynthesis.

Ciliated epithelium: Ciliated epithelium is a thin tissue that has hair-like structures on it surfaces. These hairs, called cilia, move back and forth to help move particles out of our body. We find ciliated epithelial tissue in our respiratory tract and in the fallopian tubes of women.
Collagen: Collagen is an insoluble fibrous protein found as the main structural protein in the extracellular matrix found in the body's various connective tissues; of skin, tendons and bones.it is the most abundant protein in mammals, making up from 25% to 35% of the whole-body protein content.
Collenchyma: A supporting or ground tissue composed of collenchyma cells, with additional cellulose thickening in the walls, giving them additional strength, common in regions of primary growth in stem cortex and in some leaves.
Columnar epithelial cell: Epithelium that is distinguished by elongated, prismatic or columnar cells.
Conidiospores: An asexually produced fungal spore formed on a conidiophore. Synonyms: conidium. Type of spore: a small usually single-celled asexual reproductive body produced by many nonflowering plants and fungi and some bacteria and protozoans and that are capable of developing into a new individual without sexual fusion.
Cytoplasm: The entire contents of the cell, exclusive of the nucleus, and bounded by the plasma membrane.The living matter of a cell, exclusive of the nucleus; the protoplasm.
Diatomaceous earth: Is a naturally occurring, soft, siliceous sedimentary rock that can be crumbled into a fine white to off-white powder. It has a particle size ranging from more than 3μm to less than 1mm, but typically 10 to 200μm.
Dicotyledons: Angiosperm whose seeds have two cotyledons.
Epithelial Cells: Epithelial cells are a type of cell that lines the surfaces of the body. They are found on the skin, blood vessels, urinary tract, and organs.
Eucalyptus tree: Eucalyptus is a genus of over seven hundred species of flowering trees, shrubs or mallees in the myrtle family, Myrtaceae. Along with several other genera in the tribe Eucalypteae, including Corymbia, they are commonly known as eucalypts.
Euglenoids: Any of a taxon (Euglenophyta or Euglenida) of varied flagellates (such as a euglena) that are typically green or colorless stigma-bearing solitary microorganisms with one or two flagella emerging from a well-defined gullet.
Filamentous: Thin in diameter; resembling a thread. Synonyms: filamentlike, filiform, threadlike, thready thin of relatively small extent from one surface to the opposite or in cross section.
Gelatinous matrix: An external glandular substance secreted by some invertebrates, into which the eggs are embedded or deposited.
Genetic information: Information carried in the linear sequence of nucleotides in DNA. Each molecule of DNA is a double helix formed from two complementary strands of nucleotides held together by hydrogen bonds between G-C and A-T base pairs.
Golgi vesicle: In the final stage of transport through the Golgi apparatus, modified proteins and lipids are sorted in the trans Golgi network and are packaged into vesicles at the trans face. These vesicles then deliver the molecules to their target destinations, such as lysosomes or the cell membrane.
Gonad: Gonad an organ that produces gametes; a testis or ovary.
Green Filamentous algae: Filamentous green algae form green, cottony masses that are free-floating or attached to rocks, debris, or other plants. It consists of fine, green filaments that have no leaves, roots, stems, or flowers. They often form dense mats.

Guard cell: Guard cell is a specialized plant cell in the epidermis of leaves, stems and other organs that are used to control gas exchange. They are produced in pairs with a gap between them that forms a stomatal pore.
Gymnosperm: A plant whose seeds are not enclosed within an ovary during their development (e.g. pine tree).
Hereditary material: The hereditary material present in all cells is DNA. It is passed from one generation to another through genes. Genetic information links previous generations to an individual. Individual characteristics such as hair and skin color are carried on genes together with other invisible or recessive characters.
Kingdom Protista: Consists of eukaryotic protists. Members of this very diverse kingdom are typically unicellular and fewer complexes in structure than other eukaryotes. In a superficial sense, these organisms are often described based on their similarities to the other groups of eukaryotes: animals, plants, and fungi.
Methanogen: Methanogen is a microorganism that produce methane as a metabolic by-product in oxygen-limited environments. Methanogens are mostly anaerobic organisms that cannot function under aerobic conditions. However, several species, for example, *Methanothrixparadoxum*, can generate methane under aerobic environments.
Monocotyledon: A class of angiosperm whose seeds have a single cotyledon; commonly abbreviated to monocot.
Mucilage: A viscous secretion or bodily fluid. A polysaccharide substance extracted as a viscous or gelatinous solution from plant roots, seeds, etc., and used in medicines and adhesives.
Multicellular Organisms: A multicellular organism is an organism that consists of more than one cell, in contrast to a unicellular organism.
Muscle Cell: Cell of tissues that control the internal movement of material in the body, as well as external movement.
Myosin filament: Myosin filaments (also called thick filaments) are key components of muscle and non-muscle cells. In striated muscle, they overlap with thin (actin-containing) filaments in an orderly array, making a repeating pattern of sarcomeres, the basic units of contraction.
Nervous system: Nervous system is a highly complex part of an animal that coordinates its actions and sensory information by transmitting signals to and from different parts of its body.
Nitrogen cycle: The nitrogen cycle is the biogeochemical cycle by which nitrogen is converted into multiple chemical forms as it circulates among atmosphere, terrestrial, and marine ecosystems. The conversion of nitrogen can be carried out through both biological and physical processes.
Oospore: The thick-walled zygote of certain algae and fungi, formed by fertilization of an oosphere.
Palisade Cell: Vertically elongated plant cell forming a layer rich in chloroplasts immediately beneath the upper epidermis of most leaves.
Penicillin antibiotic: Antibiotic in the penicillin class are one of the most commonly prescribed antibiotics and include many individual medications, such as penicillin G, amoxicillin, nafcillin, oxacillin, dicloxacillin, flucloxacillin, ampicillin, carbenicillin, ticarcillin, and piperacillin.

Pheromone: A type of signaling molecule secreted by exocrine glands that serves as a communication signal between individuals of the same species.
Phloem: A vascular tissue in plants that functions primarily in transporting organic food materials (e.g. sucrose) from the photosynthetic organ (leaf) to all the parts of the plant.
Photosynthetic pigment: A photosynthetic pigment is a pigment that is present in chloroplasts or photosynthetic bacteria and captures the light energy necessary for photosynthesis.
Phycobilin: Phycobilins is alight-capturing bilin found in cyanobacteria and in the chloroplasts of red algae, glaucophytes and some cryptomonads. Most of their molecules consist of a chromophore which makes them coloured.
Phytoplankton: Phytoplankton are the autotrophic components of the plankton community and a key part of ocean and freshwater ecosystems.Microscopic algae, such as diatoms and dinoflagellates that form the base of food chain in aquatic systems.
Pigment: A substance that absorbs light, often selectively.
Protist: A protist is any eukaryotic organism that is not an animal, plant, or fungus. While it is likely that protists share common ancestor, the exclusion of other eukaryotes means that protists do not form a natural group, or clade.
Pseudocoelom: Pseudocoelom is a fluid-filled body cavity lying inside the external body wall of the nematode that bathes the internal organs, including the alimentary system and the reproductive system.
Pteridophyta: A division of flowerless green plants that comprises the ferns and their relatives.
Pteridophytes: A pteridophyte is a vascular plant that disperses by spores. Because pteridophytes produce neither flowers nor seeds, they are sometimes referred to as "cryptogams", meaning that their means of reproduction is hidden. Ferns, horsetails, and lycophytes are all pteridophytes.
Reproductive Cell: Gametes are an organism's reproductive cells. They are also referred to as sex cells. Female gametes are called ova or egg cells, and male gametes are called sperm. Gametes are haploid cells, and each cell carries only one copy of each chromosome. These cells develop into sperm or ova.
Rigor mortis: Rigor mortis is a postmortem change resulting in the stiffening of the body muscles due to chemical changes in their myofibrils. Rigor mortis helps in estimating the time since death as well to ascertain if the body had been moved after death.
Sclerenchyma: A thick, rigid, often waterproof wall of the plant cell laid down after the primary wall.
Secretory Cell: Cell producing a substance or substances that are moved outside the cells.
Seed-bearing plant: The gymnosperms and the angiosperms together form the seed-bearing plants. The seed-bearing plants have been an enormously successful group in the history of life, owing to the evolution of seeds and pollen.
Skeletal muscle: Skeletal muscles (commonly referred to as muscles) is an organ of the vertebrate muscular system that are mostly attached by tendons to bones of the skeleton. The muscle cells of skeletal muscles are much longer than in the other types of muscle tissue, and are often known as muscle fibers.Capable of contracting, so producing movements or tension in the body.
Stomatal pore: Stomata are pores on the leaf surface, which are formed by a pair of curved, tubular guard cells; an increase in turgor pressure deforms the guard cells, resulting in the opening of the stomata.

Stratified epithelium: A stratified epithelium is a type of epithelial tissue that is composed of more than one layer of epithelial cells. The basal layer is the only one that is in contact with the basal lamina. This layer is also the one that undergoes mitotic division produce in cells in the upper layers.
Symbiosis: Symbiosis is a term describing any relationship or interaction between two dissimilar organisms. The specific kind of symbiosis depends on whether either or both organisms benefit from the relationship.
Thallophyta: Any of a group of plants or plantlike organisms (such as algae and fungi) that lack differentiated stems, leaves, and roots and that was formerly classified as a primary division (Thallophyta) of the plant kingdom.
Triceps muscle: Any muscle with three heads, or points of origin, particularly the large extensor along the back of the upper arm in humans. It originates just below the socket of the scapula (shoulder blade) and at two distinct areas of the humerus, the bone of the upper arm.
Trichoderma: Trichoderma is a genus of fungi in the family Hypocreaceae that is present in all soils, where they are the most prevalent culturable fungi. Many species in this genus can be characterized as opportunistic avirulent plant symbionts.
Triploblastic: Possessing three germ layers: the endoderm, mesoderm, and ectoderm. Most eumetazoa are triploblastic.
Unicellular (single cell): Unicellular organisms are made up of only one cell that carries out all of the functions needed by the organism, while multicellular organisms use many different cells to function. Unicellular organisms include bacteria, protists, and yeast.
Unicellular organism: Organismcomposed of a single cell.
Urochordata: A tunicate is a marine invertebrate animal, a member of the subphylum Tunicata. It is part of the Chordata, a phylum which includes all animals with dorsal nerve cords and notochords. The subphylum was at one time called Urochordata, and the term urochordates are still sometimes used for these animals.
Vegetative Propagation: Vegetative propagation is an asexual method of plant reproduction that occurs in its leaves, roots and stem. This can occur through fragmentation and regeneration of specific vegetative parts of plants.
Zooplankton: Zooplanktons are heterotrophic plankton. Plankton are organisms floating or drifting in oceans, seas, and bodies of fresh water. The word zooplankton is derived from the Greek zoon, meaning "animal", and planktos, meaning "wanderer" or "drifter".

CHAPTER ELEVEN

Anion: A negatively charged ion.
ATP (adenosine triphosphate): Adenosine triphosphate, an energy carrier composed of adenine, ribose, and three phosphate groups directly or indirectly transfers energy to or from nearly all metabolic pathways; produce during photosynthesis, aerobic respiration, fermentation, and other pathways.
Blood capillaries: These are tiny blood vessels with thin walls. Oxygen and nutrients from the blood can move through the walls and get into organs and tissues. The capillaries also take waste products away from tissues. Capillaries are where oxygen and nutrients are exchanged for carbon dioxide and waste.

Bulk Flow: The overall movement of water or some other liquid induced by gravity, pressure, or interplay of both.
Capillary tube: Any of the fine branching blood vessels that form a network between the arterioles and venules
Concave plasmolysis: During concave plasmolysis, the protoplasm and the plasma membrane shrink away from the cell wall in places due to the loss of water; the protoplasm is then called protoplast once it has started to detach from the cell wall. The process can be reversed.
Concentration gradient: The concentration difference of a substance per unit distance.
Contractile vacuole: A clear, fluid-filled vacuole in some groups of protists that takes up water within the cell and then contracts, expelling its contents from the cell.
Convex plasmolysis: During the convex plasmolysis, both the cell membrane and protoplasm lose so much water that they completely get detach from the cell wall. Later, the cell wall collapses and results in the destruction of the cell. This process cannot be reversed
Deplasmolysis: Deplasmolysis is the opposite process of plasmolysis; when the concentration of the solution external to a plasmolyzed cell is decreased or when solutes permeate from the external solution into the vacuole, water will reenter the vacuole, and the increase in protoplast volume leads to restoration of full turgidity.
Electrochemistry: Electrochemistry is the branch of physical chemistry concerned with the relationship between electrical potential, as a measurable and quantitative phenomenon, and identifiable chemical change, with either electrical potential as an outcome of a particular chemical change, or vice versa.
Endosmosis: Endosmosis is osmosis into a cell and occurs if external water is at a higher chemical potential.
Exocytosis: The cellular secretion of macromolecules by the fusion of vesicles with the plasma membrane.
Exosmosis: Exosmosis is osmosis out of a cell and occurs if the internal water is at a higher chemical potential.
Extracellular matrix: A large network of proteins and other molecules that surround, support, and give structure to cells and tissues in the body. The extracellular matrix helps cells attach to, and communicate with, nearby cells, and play and important role in cell growth, cell movement, and other cell functions.
Extracellular: Situated or occurring outside a cell or the cells of the body, e.g., extracellular digestion extracellular enzymes.
Facilitated Diffusion: The passive transport of specific solutes through the inside of a channel protein or carrier protein that spans the lipid bilayer of a cell membrane; the solutes simply move in the direction that diffusion would take them.
Flaccid: Limp; walled cells are flaccid in isotonic surroundings, where there is no tendency for water to enter.
Flaccidity: Of a plant part deficient in turgor.
Haemolysis: The rupture or destruction of red blood cells.
Hydroelectric turbine: Hydroelectricity, or hydroelectric power, is electricity produced from hydropower.
Hydrophobic molecule: Having an aversion to water; tending to coalesce and form droplets in water.

Hydrostatic Pressure: Hydrostatic pressure refers to the pressure that any fluid in a confined space exerts. The force of hydrostatic pressure means that as blood moves along the capillary, fluid moves out through its pores and into the interstitial space.
Hypertonic Solution: Contains a higher concentration of solutes compared to another solution. The opposite solution with a lower concentration is known as the *hypotonic solution*. Scientists must describe cell contents compared to the environment. If a cell is placed in a hypertonic solution, the cell is considered hypotonic.
Hypotonic Solution: A hypotonic solution is a solution that has a lower concentration of solute compared to the cell. A hypotonic solution example is salt water. The salt is the solute, and the water is the solvent.
Isotonic Solution: An isotonic solution is one that has the same *osmolarity*, or solute concentration, as another solution. If these two solutions are separated by a semipermeable membrane, water will flow in equal direction out of each solution and into the other. The effect is zero water flow between the two solutions, although water is moving both ways. In biology, some cells must be maintained in an isotonic solution to support cellular functions. Many animal cells, which lack a cell wall to provide support against the effects of water pressure, rely on the stability of the external environment to maintain their shape. Most animals maintain the pH and osmolarity of the fluids inside of their bodies to create isotonic solutions to bathe their cells in. This solution can carry nutrients and water, but only in proportions equal to that inside the cell.
Mesophyll cells: The ground tissue of a leaf, sandwiched between the upper and lower epidermis and specialized for photosynthesis.
Mineral element: A chemical element usually other than carbon, hydrogen, oxygen, or nitrogen that is a constituent of plant or animal tissue and in most cases found in the ash remaining after incineration of the tissue.
Osmosis: The diffusion of water, or any solvent, across a selectively permeable membrane; in the absence of other forces, the movement of water during osmosis will always be from a region of greater water potential to one of lesser water potential.
Permeability: Permeability is a measure of the ease of passage of liquids or gases or specific chemicals through the material. Permeability is determined by applying a head and determining the depth of penetration or the amount of liquid or gas passing through the sample.
Permease: A substance that catalyzes the transport of another substance across a cell membrane.
Phospholipid: A phosphorylation lipid; similar in structure to a fat, but with only two fatty acids attached to the glycerol backbone, with the third space occupied by a phosphorus-containing molecule; important components of cellular membranes.
Physiologist: An expert in or student of the branch of biology that deals with the normal functions of living organisms and their parts.
Plasmolysis: A phenomenon in walled cells in which the cytoplasm shrivels and the plasma membrane pulls away from the cell wall when the cell loses water to a hyperosmotic environment.
Plasmolyzed: To undergo plasmolysis.
Protoplasm: It is the basis of life. It is an important constituent of cell and appears as a transparent, viscous granular material, heterogeneous in composition.
Semi-permeable: (of a material or membrane) allowing certain substances to pass through it but not others, especially allowing the passage of a solvent but not of certain solutes."a semipermeable membrane".

Tonoplast: The cytoplasmic membrane surrounding the vacuole in plant cells; also called vacuolar membrane.
Turgid: Swollen, distended; referring to a cell that is firm due to water uptake.
Turgidity: Turgidity is the state of being turgid or swollen, especially due to high fluid content. In general context, turgidity refers to the condition of being bloated, distended, or swollen.
Turgor pressure: Turgor pressure is the hydrostatic pressure in excess of ambient atmospheric pressure which can build up in living, walled cells. Turgor is generated through osmotically driven inflow of water into cells across a selectively permeable membrane; this membrane is typically the plasma membrane.

CHAPTER TWELVE

Autocatalytic process: A single chemical reaction is said to be autocatalytic if one of the reaction products is also a catalyst for the same or a coupled reaction. Such a reaction is called an autocatalytic reaction.
Auxesis: Growth in animal or plant tissues resulting from an increase in cell size without cell division.
Cancer: A type of malignant tumor, the cells of which show profound abnormalities in the plasma membrane and cytoplasm, abnormal growth and division, and weakened capacity for adhesion within the parent tissue (leading to metastasis), and, unless eradicated, lethality.
Cell Differentiation: Cell differentiation may simply be described as the process through which a young and immature cell evolves into a specialized cell, reaching its mature form and function. For such unicellular organisms like bacteria, various life functions occur within a single cell. That is, such processes as the transport of molecules, metabolism and reproduction all take place within a single cell given that they are single celled. However, multicellular organisms require different types of cells for these processes to be possible.
Cell Growth: Cell growth refers to the increase in cell size (mass accumulation) while cell division describes the division of a mother cell into two daughter cells.
Cell Proliferation: Cell proliferation is the process of generating an increased number of cells through cell division.
Cell Specialization: The process in which cells develop in different ways to perform different tasks.
Cellular degradation: The condition or process of degrading or being degraded.
Clone: A group of genetically identical cells or organisms produced asexually from a common ancestor.
Cloning techniques: Cloning is the process of producing individual organisms with either identical or virtually identical DNA, either by natural or artificial means. In nature, some organisms produce clones through asexual reproduction. In the field of biotechnology, cloning is the process of creating cloned organisms (copies) of cells and of DNA fragments (molecular cloning).
Embryonic development: Is the process that occurs after the fertilization of an ovule or ovum to produce a fully developed embryo. In plants this is a pertinent stage in the cycle that is followed by dormancy and germination
Endocytosis: The uptake of material into cells by means of invagination of the plasma membrane; if solid material is involved, the process is called phagocytosis; if dissolved material is involved, it is called pinocytosis.

Endoreplication: Endoreduplication (also referred to as endoreplication or endocycling) is replication of the nuclear genome in the absence of mitosis, which leads to elevated nuclear gene content and polyploidy. It is an evolutionarily conserved cell cycle program during which cells replicate their genomes without division resulting in polyploidy cells.
Erythropoietic tissues: Erythropoiesis (from Greek 'erythro' meaning "red" and 'poiesis' "to make") is the process which produces red blood cells (erythrocytes), which is the development from erythropoietic stem cell for mature red blood cell.tissues responsible for the formation of red blood cells.
Genotypes: The totality of the gene content of an organism; may or may not be visibly expressed, as contrasted with phenotype.
Germinativum: The stratum basal (basal layer, sometimes referred to as stratum germinativum) is the deepest layer of the five layers of the epidermis, the external covering of skin in mammals. The cells are attached to each other and to the overlying stratum spinosum cells by desmosomes and hemidesmosomes.
Hyperplasia: Excessive development due to increase in number of cells.
Hypertrophy: Excessive growth due to increase in size of cells.
Malignant Tumor: A cancerous growth; an abnormal growth whose cells multiplies excessively, has altered surfaces, and may have unusual numbers of chromosomes and or arberant metabolic processes.
Meristematic cells: Relating to or denoting a region of plant tissue consisting of actively dividing cells forming new tissue,"meristematic cells located in the tip of the root".
Micro-propagation: Large-scale clonal propagation.
Morphogenesis: The total expression of the morphological phenomena of differentiation and development of tissues and organs.
Mutagen: An environmental agent that can permanently modify the structure of a DNA molecule. Certain viruses and ultraviolet radiation are examples.
Palisade cell: Palisade cellis a plant cell located on the leaves, right below the epidermis and cuticle. In simpler terms, they are known as leaf cells. They are vertically elongated, a different shape from the spongy mesophyll cells beneath them.
Periosteum cell: Dense fibrous membrane covering the surfaces of bones, consisting of an outer fibrous layer and an inner cellular layer (cambium). It also contains many blood vessels, branches of which penetrate the bone to supply the osteocytes, or bone cells.
Phellen: Outer tissue of bark; a protective layer of dead cells. synonyms: cork. type of: bark. tough protective covering of the woody stems and roots of trees and other woody plants.
Phelloderm: A layer of thin-walled cells produced by the inner surface of the cork cambium.
Phenotype: A phenotype is an individual's observable traits, such as height, eye color, and blood type. The genetic contribution to the phenotype is called the genotype. Some traits are largely determined by the genotype, while other traits are largely determined by environmental factors.
Protoplasmic content: Protoplasm is a mixture of small molecules such as ions, monosaccharides, amino acid, and macromolecules such as proteins, polysaccharides, lipids, etc.
Protoplasmic mass: The fluid living content of the cell that consists of two major divisions, the cytoplasm and the nucleoplasm (cell nucleus), and composed primarily of nucleic acids, proteins, lipids, carbohydrates, and inorganic salts.

Protoplasmic material: Protoplasm is the living part of a cell that is surrounded by a plasma membrane. In some definitions, it is a general term for the cytoplasm, but for others, it also includes the nucleoplasm.
Sieve tube: A series of sieve tube elements placed end to end to form a continuous tube.
Spongy mesophyll cell: The spongy mesophyll cells are covered by a thin layer of water. Gases dissolve in this water as they move into and out of the cells. When the plant is photosynthesizing during the day, these features allow carbon dioxide to diffuse into the spongy mesophyll cells, and oxygen to diffuse out of them.

CHAPTER THIRTEEN

Aquatic autotroph: Algae, which live in water and whose larger forms are known as seaweed. Phytoplankton, tiny organisms that live in the ocean, are also autotrophs. Some types of bacteria are autotrophs. Most autotrophs use a process called photosynthesis to make their food.
Aquatic primary producers: Primary producers — including bacteria, phytoplankton, and algae — form the lowest trophic level, the base of the aquatic food web. Primary producers synthesize their own energy without needing to eat.
Autotrophic organism: An autotroph or primary producer is an organism that produces complex organic compounds using carbon from simple substances such as carbon dioxide, generally using energy from light or inorganic chemical reactions.
Bacteriochlorophyll: A tetrahydroporphyrin chlorophyll compound ($C_{52}H_{70}O_6N_4Mg$) occurring in the forms a and b in photosynthetic bacteria.
Bacterioviridin: Bacterioviridin is a pigment found in photosynthetic green sulfur bacteria, unlike bacteriochlorophyll which is present in purple sulfur and purple non-sulfur bacterias. It consists of chlorobium chlorophyll as the major component.
Biological oxidation: Biological oxidation devices convert biodegradable organic compounds into carbon dioxide and water. This is a natural occurring process which differs from traditional chemical and thermal oxidizing agents and methods.
Calvin Cycle: The series of enzymatically mediated photosynthetic reactions during which carbon dioxide is reduced to 3-phophoglyceraldehyde and the carbon dioxide acceptor, ribulose 1, 5-bisphosphate, is generated. For every three molecules of carbon dioxide entering the cycle, a net gain of one molecule of glyceraldehyde 3-phosphate results.
Carbon fixation reaction: In photosynthetic cells, the light-independent enzymatic reactions concerned with the synthesis of glucose from CO_2, ATP, and NADPH; also called light-independent reactions and dark reactions.
Carboxylation: A functional group present in aldehydes and ketones, consisting of a carbon atom double-bounded to an oxygen atom.
Carotene molecule: Carotene is a polyene with the end consisting of either one or two unsaturated cycles. They are considered tetraterpenes, having the general formula $C_{40}H_{56}$. Carotenes are present in plants and are related to several other compounds of biological importance such as retinal and vitamin A (retinol). The most common carotenes are α-carotene and β-carotene.
Carotenoid: A class of fat-soluble pigments that includes the carotenes (yellow and orange pigments) and the xanthophylls (yellow pigments); found in chloroplasts and chromoplasts of plants. Carotenoids act as accessory pigments in photosynthesis.
Cellular respiration: Process that releases energy by breaking down glucose and other food molecules in the presence of oxygen.

Chemoautotrophic: An organism that uses only carbon dioxide as a carbon source but obtains energy by oxidizing inorganic substances.
Chemosynthesis: The process where the energy obtained by oxidation of inorganic materials like ammonia, nitrite, hydrogen sulfide etc. is utilized by some microorganisms for the synthesis of food from CO_2. Light is not utilized in this process. Process by which some organisms, such as certain bacteria, use chemical energy to produce carbohydrates.
Chemosynthetic bacteria: Bacteria that obtain energy required for metabolic processes from exothermic oxidation of inorganic or simple organic compounds without the aid of sun light.
Chlorophyll molecule: A green pigment located within the chloroplasts of plants; chlorophyll a can participate directly in the light reactions, which converts solar energy to chemical energy.
Chloroplast: Plant cell organelle that carries out photosynthesis.
Compensation point: The light intensity at which the amount of carbon dioxide released in respiration equals the amount uses in photosynthesis and the amount of oxygen used in respiration equals the amount released in photosynthesis, varying in different species of plants and in response to changes in temperature and other environmental.
Cyclic Photophosphorylation: The production of ATP during the cyclic pathway of electron flow.
Cytochrome: One of a group of conjugated, iron containing proteins which serve as hydrogen carriers in aerobic respiration.
Dark Reactions: A group of light-independent reactions following the light reactions in photosynthesis; they reduce carbon dioxide to produce and other carbohydrates.
Dicotyledonous leaves: A leaf with a pinnated pattern (like a feather) has a central vein running down the middle of the leaf with other veins branching off to either side of it. A leaf with a palmate pattern has veins branching out from a single one to form a shape resembling the palm of a hand.
Dimorphic chloroplast: Dimorphic chloroplasts are the chloroplasts which are concentrated into two types of cells having different size and structure. The dimorphic chloroplast is present in C4 plants because of the presence of special leaf anatomy called Kranz anatomy.
Ecosystem: A major interacting system that involves both living organisms and their physicalenvironmental.
Etiolated leaves: The distinctive development of plants in the absence of light is called etiolation. In the dark, higher plants show weak growth. In docots, the stem is excessively elongated and the leaves are under developed. Little differentiation of tissue occurs and the tissues mostly remain parenchymatous. Leaves are pale yellow in colour because of lack of chlorophyll.
Five-carbon sugar: A five-carbon sugar found in the DNA is **deoxyribose**. It forms the central molecule in a nucleotide.
Food chain: A chain of organisms existing in any natural community such that each link in the chain feeds on the one below and is eaten by the above; there are seldom more than six links in a chain, with autotrophs on the bottom and the largest carnivores at the top.
Furamic acid: Fumaric acid is an important specialty chemical with wide industrial applications ranging from its use as feedstock for the synthesis of polymeric resins to acidulant in foods and pharmaceuticals. Currently, fumaric acid is mainly produced by petroleum-based chemical synthesis.

Glutamic dehydrogenase: Glutamate dehydrogenase (GDH) is a hexameric enzyme that catalyzes the reversible conversion of glutamate to α-ketoglutarate and ammonia while reducing NAD (P) + to NAD (P) H. It is found in all living organisms serving both catabolic and anabolic reactions.

Guard cell: Guard cells are specialized plant cells in the epidermis of leaves, stems and other organs that are used to control gas exchange. They are produced in pairs with a gap between them that forms a stomatal pore.

Homogenous: Homogenous most generally means consisting of parts or elements that are all the same. Something that is homogenous is uniform in nature or character throughout. Homogenous can also be used to describe multiple things that are all essentially alike or of the same kind.

Hormone: A hormone is any member of a class of signaling molecules in multicellular organisms that are transported by intricate biological processes to distant organs to regulate physiology and behavior. Hormones are required for the correct development of animals, plants and fungi.

Hydrothermal micro-organism: The hydrothermal vent microbial community includes all unicellular organisms that live and reproduce in a chemically distinct area around hydrothermal vents. These include organisms in the microbial mat, free floating cells, or bacteria in an endosymbiotic relationship with animals.

Inorganic compound: Inorganic compound, any substance in which two or more chemical elements (usually other than carbon) are combined, nearly always in definite proportions. Compounds of carbon are classified as organic when carbon is bound to hydrogen. Carbon compounds such as carbides (e.g., silicon carbide [SiC2]), some carbonates (e.g., calcium carbonate [CaCO3]), some cyanides (e.g., sodium cyanide [NaCN]), graphite, carbon dioxide, and carbon monoxide are classified as inorganic.

Kranz Anatomy: Kranz means wreath and is a reflection of arrangement of cells. The bundle sheath cells may form several layers around the vascular bundles are characterised by large number of chloroplasts, thick walls for gaseous exchange and no intercellular spaces. Example, maize.

Light Independent Stage: The light-independent reactions (also known as the Calvin cycle) can be organized into three basic stages: fixation, reduction, and regeneration. Light-dependent reactions harness energy from the sun to produce chemical bonds, ATP, and NADPH.

Light Reaction: The reactions of photosynthesis that require light and cannot occur in the dark; also called light-dependent reactions and energy-transduction reactions.

Lithotropic bacteria: Lithotrophs are a diverse group of organisms using an inorganic substrate (usually of mineral origin) to obtain reducing equivalents for use in biosynthesis (e.g., carbon dioxide fixation) or energy conservation (i.e., ATP production) via aerobic or anaerobic respiration.

Mesophyll cell: Mesophyll cells are a type of ground tissue found in the plant's leaves. There are two types of mesophyll cells: Palisade mesophyll cells and spongy mesophyll cells. The most important role of the mesophyll cells is in photosynthesis.

Mineral Element: Calcium Ca and Phosphorus P. Calcium and phosphorus are the chief elements of the skeleton; 99% of the calcium and about 80% of the phosphorus found in the body are located in the bones and teeth. Magnesium Mg, Sodium Na, Potassium K, Chlorine Cl, Sulphur S, Iron Fe, Copper Cu, Manganese Mn and Zinc Zn.

Mineral salt: Mineral salts are inorganic salts that need to be ingested or absorbed by living organisms for healthy growth and maintenance. They comprise the salts of the trace elements in animals and the micronutrients of plants.

Nitrosomonas: Is a genus of Gram-negative bacteria, belonging to the Betaproteobacteria. It is one of the five genera of ammonia-oxidizing bacteria and, as an obligate chemolithoautotroph, uses ammonia as an energy source and carbon source in presence of oxygen.

Non-cyclic chain: Not relating to or occurring in cycles: not cyclic a noncyclic processes a noncyclical industry.

Non-cyclic Photophosphorylation: The production of ATP by noncyclic electron flow.

Optimum temperature: Optimum temperature is the temperature at which an enzyme shows its highest catalytic activity, a decrease or increase in the temperature below or above the optimum temperature results in decrease in activity.

Oxaloacetic acid: A crystalline acid $C_4H_4O_5$ that is formed by reversible oxidation of malic acid (as in carbohydrate metabolism via the Krebs cycle) and in reversible transamination reactions (as from aspartic acid).

Phosphenol pyruvic acid: Phosphoenolpyruvic acid, an intermediary metabolite of glycolysis, as a potential cytoprotectant and anti-oxidant in HeLa cells. Phosphoenolpyruvate is the ester derived from the enol of pyruvate and phosphate. It exists as an anion. PEP is an important intermediate in biochemistry. It has the highest-energy phosphate bond found in organisms, and is involved in glycolysis and gluconeogenesis.

Photolysis of water: The light-dependent oxidative splitting of water molecules that takes place in photosystem II of the light reactions of photosynthesis.

Photon: The elementary particle of lights.

Photophosphorylation: The formation of ATP in the chloroplast during photosynthesis.

Photosynthetic cell: Photosynthetic cells contain chlorophyll and other light-sensitive pigments that capture solar energy. In the presence of carbon dioxide, such cells are able to convert this solar energy into energy-rich organic molecules, such as glucose.

Photosynthetic enzyme: Phosphoenolpyruvate carboxylase (PEPC), NADP-malic enzyme (NADP-ME), and pyruvate, phosphate dikinase (PPDK) participate in the process of concentrating CO_2 in C_4 photosynthesis.

Photosynthetic process: During photosynthesis, plants take in carbon dioxide (CO2) and water (H2O) from the air and soil. Within the plant cell, the water is oxidized, meaning it loses electrons, while the carbon dioxide is reduced, meaning it gains electrons. This transforms the water into oxygen and the carbon dioxide into glucose.

Photosystem: Light-collecting units of the chloroplast.

Plastocyanin: Is a copper-containing protein that mediates electron-transfer. It is found in a variety of plants, where it participates in photosynthesis. The protein is a prototype of the blue copper proteins, a family of intensely blue-colored metalloproteins. Specifically, it falls into the group of small type I blue copper proteins called "cupredoxins".

Primary Producer: An organism such as a plant that directly or indirectly nourishes consumers, decomposers and detritivores.

Protein synthesis: Protein synthesis is the process of creating protein molecules. In biological systems, it involves amino acid synthesis, transcription, translation, and post-translational events. In amino acid synthesis, there is a set of biochemical processes that produce amino acids from carbon sources like glucose.

Quantum: A quantum (plural: quanta) is the smallest discrete unit of a phenomenon. For example, a quantum of light is a photon, and a quantum of electricity is an electron. Quantum comes from Latin, meaning "an amount" or "how much?" If something is quantifiable, then it can be measured.

Reaction center: A photosynthetic reaction center is a complex of several proteins, pigments and other co-factors that together execute the primary energy conversion reactions of photosynthesis.

Ribosome synthesis: The ribosome is universally responsible for synthesizing proteins by translating the genetic code transcribed in mRNA into an amino acid sequence. Ribosomes use cellular accessory proteins, soluble transfer RNAs, and metabolic energy to accomplish the initiation, elongation, and termination of peptide synthesis.

Scaleworms: Polynoidae is a family of marine Polychaete worms known as "scale worms" due to the scale-like elytra on the dorsal surface. Almost 900 species are currently recognised belonging to 9 subfamilies and 167 genera. They are active hunters, but generally dwell in protected environments such as under stones.

Sclerenchyma: Sclerenchyma is a general term used to denote a tissue or cell type that has lignified walls.

Secondary consumer: Secondary consumeris an organism that eat primary consumers for energy. Primary consumers are always herbivores, or organisms that only eat autotrophic plants. However, secondary consumers can either be carnivores or omnivores. Carnivores only eat other animals, and omnivores eat both plant and animal matter.

Six-carbon compound: There are several different types of compounds, including binary, ionic, molecular, acids, cations, and anions. These types of compounds have different properties and different chemical makeups, but they are the categories that describe the potentially millions of different chemical compounds.

Stroma: The ground substance of plastids. The fluid of the chloroplasts surrounding the thylakoid membrane; involved in the synthesis of organic molecules from carbon dioxide and water.Region outside the thylakoid membranes in chloroplasts.

Sulphur bacteria: Any of a diverse group of microorganisms capable of metabolizing sulfur and its compounds and important in the sulfur cycle (*q.v.*) in nature. Some of the common sulfur substances that are used by these bacteria as an energy source are hydrogen sulfide (H_2S), sulfur, and thiosulfate ($S_2O_3^{2-}$). The final product of sulfur oxidation is sulfate (SO_4^{2-}).

Transamination process: Transamination is the process by which amino groups are removed from amino acids and transferred to acceptor keto-acids to generate the amino acid version of the keto-acid and the keto-acid version of the original amino acid.

Triose phosphate: Muscle triose phosphate isomerise (TIM, or TPI) is a dimeric enzyme which catalyses the interconversion of glyceraldehyde-3-phosphate (G-3-P) and dihydroxyacetone-phosphate (DHAP).

Wavelength: Wavelength is the distance between identical points (adjacent crests) in the adjacent cycles of a waveform signal propagated in space or along a wire. In wireless systems, this length is usually specified in meters (m), centimeters (cm) or millimeters (mm).

CHAPTER FOURTEEN

Acetic acid: Acetic acid is also known as ethanoic acid, ethylic acid, vinegar acid, and methane carboxylic acid; it has the chemical formula of CH_3COOH. Acetic acid is a byproduct of fermentation, and gives vinegar its characteristics odor. Vinegar is about 4-6% acetic acid in water.

Active Transport: The expenditure of energy by a cell in moving a substance across a plasma membrane against a diffusion gradient.

Adenosine Diphosphate: A molecule involved in cellular energy transfers; typically formed by hydrolysis of ATP.

Adenosine monophosphate: Adenosine monophosphate (AMP), also known as 5'-adenylic acid, is **a nucleotide**. AMP consists of a phosphate group, the sugar ribose, and the nucleobase adenine; it is an ester of phosphoric acid and the nucleoside adenosine. As a substituent it takes the form of the prefix adenylyl-.

Aerobic Respiration: A process whereby there is a complete oxidation of foods by the atmospheric oxygen in living cells with the accompanying release of energy, CO_2 and water being end products.

Alcoholic fermentation: Alcoholic fermentation is a complex biochemical process during which yeast convert sugars to ethanol, carbon dioxide, and other metabolic byproducts that contribute to the chemical composition and sensorial properties of the fermentation foodstuffs.

Amphibian: Amphibianis a small vertebrate that need water, or a moist environment, to survive. The species in this group include frogs, toads, salamanders, and newts. All can breathe and absorb water through their very thin skin. Amphibians also have special skin glands that produce useful proteins.

Anaerobic Respiration: A form of respiration that occurs in a few groups of bacteria living in anaerobic environments such as soil; the final electron acceptors are sulfate and nitrate.

Breathing: Breathing is the process of moving air into and from the lungs to facilitate gas exchange with the internal environment, mostly to flush out carbon dioxide and bring in oxygen.

Butyric acid: Also known under the systematic name butanoic acid, is a straight chain alkyl carboxylic acid with the chemical formula $CH_3CH_2CH_2CO_2H$. It is an oily, colorless liquid with an unpleasant odor.

Cell respiration: Cell respiration is a set of metabolic reactions and processes that takes place in the cells of organisms to convert chemical energy from nutrients into adenosine triphosphate (ATP), and then release waste products.

Chemical bond: A chemical bond is a lasting attraction between atoms, ions or molecules that enables the formation of chemical compounds. The bond may result from the electrostatic force between oppositely charged ions as in ionic bond or through the sharing of electrons as in covalent bonds.

Chemiosmotic theory: Chemiosmotic theory states that the transfer of electrons down an electron transport system through a series of oxidation-reduction reactions releases energy. This energy allows certain carriers in the chain to transport hydrogen ions (H^+or protons) across a membrane.

Coenzyme: An organic molecule, or nonprotein organic cofactor, that plays an accessory role in enzyme-catalyzed processes, often by acting as a donor or acceptor of electrons; NAD^+ and FAD are common coenzymes.

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Cristae: A cristae is a fold in the inner membrane of a mitochondrion. The name is from the Latin for crest or plume, and it gives the inner membrane its characteristics wrinkled shape, providing a large amount of surface area for chemical reactions to occur on.
Cytochromes: One of a group of conjugated, iron containing proteins which serve as hydrogen carriers in aerobic respiration.
Electron Transport Chain: A group of molecules in the inner membrane of a mitochondrion that synthesize ATP by means of an exergonic slide of electrons. Thylakoid membranes of chloroplasts are also equipped with electron transport chains.
Enzymatic reaction: An enzyme attracts substrates to its active site, catalyzes the chemical reaction by which products are formed, and then allows the products to dissociate (separate from the enzyme surface). The combination formed by an enzyme and its substrates is called the enzyme-substrate complex.
External Respiration: External respiration is the formal term for gas exchange. It describes both the bulk flow of air into and out of the lungs and the transfer of oxygen and carbon dioxide into the bloodstream through diffusion.
Fermentation: A catabolic process that makes a limited amount of ATP from glucose without an electron transport chain and that produces a characteristic end-product, such as ethyl alcohol or lactic acid.
Gaseous Exchange: The transfer of gases between an organism and the external environment in either direction. It occurs by diffusion across a concentration gradient and includes the exchange of oxygen and carbon dioxide in respiration and photosynthesis.
Glycolysis: The anaerobic breakdown of glucose to form two molecules of pyruvate, resulting in the net liberation of two molecules of ATP; catalyzed by enzymes in the cytosol.
Hydrolysis: Splitting of one molecule into two by addition of the H^+ and OH^- ions of water.
Inhalation: Inhalation is the process or act of breathing in, taking air and sometimes other substances into your lungs.
Krebs' cycle: The series of reactions that results in the oxidation of pyruvate to hydrogen atoms, electrons, and carbon dioxide. The electrons, passed along electron-carrier molecules, then go through the oxidative phosphorylation and terminal oxidation process. Also called the tricarboxylic acid cycle or TCA cycle.
Lactic acid: Lactic acid, or lactate, is a chemical byproduct of anaerobic respiration — the process by which cells produce energy without oxygen around. Bacteria produce it in yogurt and our guts. Lactic acid is also in our blood, where it's deposited by muscle and red blood cells.
Leavening: A substance used to make baked goods rise by the formation of gas, esp. carbon dioxide, in the batter or dough, as baking powder, yeast, etc.
Macromolecule: A molecule of very high molecular weight; refers specifically to proteins, nucleic acids, polysaccharides, and complexes of these.

Mitochondria: Structures within the cytoplasm of eukaryotic cells that carries out aerobic respiration, it is the site of the Krebs cycle and electron transport chain and therefore the cell's energy production.
Oxalic acid: Oxalic acid is an organic acid with the IUPAC name ethanedioic acid and formula HO2C-CO2H. It is the simplest dicarboxylic acid. It is a white crystalline solid that forms a colorless solution in water.
Oxidative decarboxylation: Oxidative decarboxylation reactions are oxidation reactions in which a carboxylate group is removed, forming carbon dioxide. They often occur in biological systems: there are many examples in the citric acid cycle. This type of reaction probably started early at the origin of life.
Oxidative Phosphorylation: The formation of ATP from ADP and inorganic phosphate; oxidative phosphorylation takes place in the electron-transport chain of the mitochondrion.
Phosphorylation: A reaction in which phosphate is added to a compound; for example, the formation of ATP from ADP and inorganic phosphate.
Pyruvate molecule: Pyruvate is an important chemical compound in biochemistry. It is the output of the metabolism of glucose known as glycolysis. One molecule of glucose breaks down into two molecules of pyruvate, which are then used to provide further energy, in one of two ways.
Pyruvic acid: Pyruvic acid is a water-soluble, organic liquid that is produced by breaking down carbohydrates and sugars through the glycolytic pathway (glycolysis). If oxygen is available, pyruvic acid is converted to acetyl coenzyme A that enters the energy-producing pathway, the Krebs cycle.
Reoxidized: To oxidize again, or to become oxidized again, after a period of reduction.
Respiration: The cellular breakdown of sugar and other foods, accompanied by release of energy; in aerobic respiration, oxygen is utilized.
Respiratory chain: The respiratory chain consists of a series of four transmembrane proteins which transport electrons from NADH and succinate formed in the Krebs cycle to molecular oxygen.
Respiratory quotient: The respiratory quotient, also known as the respiratory ratio (RQ), is defined as the volume of carbon dioxide released over the volume of oxygen absorbed during respiration. It is a dimensionless number used in a calculation for basal metabolic rate when estimated from carbon dioxide production to oxygen absorption.
Succinic dehydrogenase: An enzyme that catalysis the removal of hydrogen atoms from a particular molecule, particularly in the electron transport chain reactions of cell respiration in conjunction with the coenzymes NAD and FAD "glucose-6-phosphate dehydrogenase".
Tricarboxylic Acid Cycle: A stage of tissue respiration: a series of biochemical reactions occurring in mitochondria in the presence of oxygen by which acetate, derived from the breakdown of foodstuffs, is converted to carbon dioxide and water, with the release of energy. Also called: citric acid cycle, tricarboxylic acid cycle.
Ventilation: The movement of air between the environment and the lungs via inhalation and exhalation.

CHAPTER FIFTEEN

Acidophilic: Are those that thrive under highly acidic conditions (usually at pH 2.0 or below). These organisms can be found in different branches of the tree of life, including Archea, Bacteria, and Eukarya.

Alcoholic solution: An alcoholic solution is mixture of water and ethanol, used as a solvent. Substances containing sugar can ferment into an alcoholic solution containing ethanol.

Animal tissue: Animal tissues are made up of animal cells that have been gathered together. The structure, function, and origin of these tissues are all different. Epithelial, connective, muscular, and nervous tissues are the four types of tissues found in animals.

Anisotropic Material: Anisotropic materials, also known as "triclinic" materials, are direction-dependent mediums that are made up of unsymmetrical crystalline structures. In other words, the mechanical properties of anisotropic materials depend on the orientation of the materials body.

Annulus: An annulus in botany is an arc or a ring of specialized cells on the sporangium. These cells are arranged in a single row, and are associated with the release or dispersal of spores.

Basophilic: Basophilic is a technical term used by pathologists. It describes the microscopic appearance of cells and tissues, as seen down the microscope, after a histological section has been stained with a basic dye. The most common such dye is haematoxylin.

Cell culturing: Cell culturing refers to the removal of cells from an animal or plant and their subsequent growth in a favourable artificial environment.

Cell fractionation: Fractionation is a separation process in which a certain quantity of a mixture (gas, solid, liquid, enzymes, suspension, or isotope) is divided during a phase transition, into a number of smaller quantities (fractions) in which the composition varies according to a gradient.

Cell organelle: Organelle is a specialized structures that perform various jobs inside cells. The term literally means "little organs". In the same way organs, such as the heart, liver, stomach, and kidneys, serve specific functions to keep an organism alive, organelles serve specific functions to keep a cell alive.

Centrifugation: Centrifugation is a technique that helps to separate mixtures by applying centrifugal force. A centrifuge is a device, generally driven by an electric motor that puts an object, e.g., a rotor, in a rotational movement around a fixed axis. Pelleting is the most common application for centrifuges. A centrifuge is a device that uses centrifugal force to separate various components of a fluid. This is achieved by spinning the fluid at high speed within a container, thereby separating fluids of different densities or liquids from solids.

Coarse adjustment knob: A rapid control which allows for quick focusing by moving the object lens or stage up and down.

Compound Microscope: A compound microscope is a high power (high magnification) microscope that uses a compound lens system. A compound microscope has multiple lenses: the **objective lens** (typically 4x, 10x, 40 xs or 100 xs) is compounded (multiplied) by the **eyepiece lens** (typically 10 xs) to obtain a high magnification of 40x, 100x, 400x and 1000x. Higher magnification is achieved by using two lenses rather than just a single magnifying lens.

While the eyepieces and the objective lenses create high magnification, a condenser beneath the stage focuses the light directly into the sample.

Culture medium: A culture medium is a mixture of substances that promotes and supports the growth and differentiation of microorganisms. Culture media contain nutrients, energy sources, growth-promoting factors, minerals, metals, buffer salts, and gelling agents (for solid media).

Dehydration: A dangerous loss of body fluid caused by illness, sweating or inadequate intake.

Electron beam: A stream of electrons (small negatively charged particles found in atoms) that can be used for radiation therapy.

Electron Microscope: Microscope that forms an image by focusing beams of electrons onto a specimen.

Eosin: Eosin can be used to stain cytoplasm, red blood cells, collagen, and muscle fibres for histological examination. It is most often used as a counterstain to hematoxylin in H&E staining. In H&E, eosin Y is typically used in concentrations of 0.5-1% (0.5-1g eosin Y in 100 ml distilled water or 75% ethanol).

Fine adjustment knob: A slow but precise control used to fine focus the image when viewing at the higher magnifications.

Fixation: Process in soil by which certain chemical elements essential for plant growth are converted from a soluble or exchangeable form to a less soluble or nonexchangeable form.

Germination: The beginning or resumption of growth of a seed or spore.

Heavy metal: Any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Examples of heavy metals include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thalium (Tl), and lead (Pb).

Homogenization: Homogenization is commonly defined as a chemical or physical treatment by which the composition or structure of a substance (solid, liquid or gas) or mixture of substances is made uniform.

Human carcinoma: Carcinoma is a type of cancer that starts in cells that makes up the skin of the tissue linning organs, such as the liver or kidneys. Like other types of cancer, carcinomas are abnormal cells that divide without control. They are able to spread to other parts of the body, but don't always.

Hydrolytic Enzyme: Hydrolytic enzyme break down protein, lipids, nucleic acids, carbohydrate and fat molecules into their simplest units.

Iris diaphragm: It controls the angle of the beam of light focused onto the specimen. The iris diaphragm is an adjustable shutter which allows you to adjust the amount of light passing through the condenser. The angle determines the Numerical Aperture (NA) of the condenser.

Light Microscope: An optical instrument with lenses that refract (bend) visible light to magnify images of specimens.

Magnified image: Magnified image is the method of enlarging something as an optical image or the ratio of image size to object size. A magnified image is one that has been magnified by a mirror or lens. Magnification is the size of an image in relation to the size of the object that produced in its optics.

Microscope's magnification: A microscope's total magnification is a combination of the eyepieces and the objective lens. For example, a biological microscope with 10x eyepieces and a 40x objective has 400 x magnifications.

Mechanical stage: A mechanical stage is a microscope attachment that holds slides in place and allows the user to precisely control their position. These devices can be useful for manipulating slides at high magnifications and in delicate operations where position is very important.

Microscope: A microscope is a laboratory instrument used to examine objects that are too small to be seen by the naked eye. Microscopy is the science of investigating small objects and structures using a microscope. Microscopic means being invisible to the eye unless aided by a microscope.

Microscopic slide: A microscopic slide is a thin flat piece of glass, typically 75 by 26 mm and about 1mm thick, used to hold objects for examination under a microscope. Typically the object is mounted on the slide, and then both are inserted together in the microscopic for viewing.

Microscopist: Microscopist - a scientist who specializes in research with the use of microscopes. Scientist - a person with advanced knowledge of one or more sciences.

Micro-technique: Is an aggregate of methods used to prepare micro-objects for studying. It is currently being employed in many fields in life science. Two well-known branches of microtechnique are botanical (plant) microtechnique and zoological (animal) microtechnique.

Microtome: A microtome (from the Greek mikros, meaning "small", and temnein, meaning "to cut") is a cutting tool used to produce extremely thin slices of material known as sections. Microtomes use steel, glass or diamond blades depending upon the specimen being sliced and the desired thickness of the sections being cut.

Nucleic acid: Nucleic acid is a large biomolecules that play essential roles in all cells and viruses. A major function of nucleic acids involves the storage and expression of genomic information. Deoxyribonucleic acid, or DNA, encodes the information cells need to make proteins.

Objective lens: The objective lens consists of several lenses to magnify an object and project a larger image. According to the difference of the focal distance, lenses of different magnifications are available, such as 4x, 10x, 40x, and 50x.

Optical system: A combination of lenses, mirrors, and prisms that constitutes the optical part of an optical instrument (as a microscope or telescope).

Ordinary Light Microscope: The optical microscope, also referred to as a light microscope, is a type of microscope that commonly uses visible light and a system of lenses to generate magnified images of small objects. The object is placed on a stage and may be directly viewed through one or two eyepieces on the microscope.

Phase-contrast–microscope: Phase contrast is a light microscopy technique used to enhance the contrast of images of transparent and colourless specimens. It enables visualisation of cells and cell components that would be difficult to see using an ordinary light microscope.

Photographic emulsion: A light-sensitive coating on paper or film; consists of fine grains of silver bromide suspended in a gelatin. Photographic emulsions convert incident radiation into chemical changes made visible by the development process.

Photographic film: Photographic film is a material that is used in photographic cameras for recording images. It is made of transparent plastic in a shape of a strip or sheet and it has one side covered with light-sensitive silver halide crystals made into a gelatinous emulsion.
Photographic plate: A flat sheet of metal or glass on which a photographic image can be recorded.
Polarizing Microscope: Polarized light microscopy can mean any of a number of optical microscopy techniques involving polarized light. Simple techniques include illumination of the sample with polarized light. Directly transmitted light can, optionally, be blocked with a polarizer orientated at 90 degrees to the illumination.
Primary culture: A primary cell culture refers to cells that have been removed from a live donor/specimen and have been established in an in *vitro* environment.
Radioactive atom: An atom with an unstable nucleus, which emits particulate or electromagnetic radiation (radioactive emission) to achieve greater stability.
Radioactive isotope: One of two or more forms of an element that have the same chemical properties but differ in the number of neutrons in the nuclei of their atoms.
Radioactive molecule: A radioactive isotope, also known as a radioisotope, radionuclide, or radioactive nuclide, is any of several species of the same chemical element with different masses whose nuclei are unstable and dissipate excess energy by spontaneously emitting radiation in the form of alpha, beta, and gamma rays.
Resolvancy: The state of being resolved.
Resolving power: Resolving power is defined as the ability of a microscope or telescope to distinguish two close together images as being separate. An example of resolving power is how well a telescope can show two stars as being separate stars.
Scanning Electron Microscope: A scanning electron microscope is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample.
Scanning Electron Microscope: Scanning Electron Microscope (SEM) projects and scans a focused stream of electrons over a surface to create an image. The electrons in the beam interact with the sample, thereby producing various signals that can be used to obtain information about the surface's topography and composition.
Secondary culture: Secondary cell culture refers to cell lines that have been immortalized, usually by overexpressing an enzyme called human telomerase reverse transcriptase (hTERT), and can divide indefinitely. Many tissue types are not amendable to immortalization, so primary cell culture may be the only option in some circumstances.
Smear: A sample of tissue or other material taken from part of the body, spread thinly on a microscope slide for examination, typically for medical diagnosis.
Specimen: An individual, item, or part considered typical of a group, class, or whole. A portion or quantity of material for use in testing, examination, or study a urine specimen.

Squash: To squash is to beat or press into pulp or a flat mass; or crush. However, Squashis the smearing or compressing of a thin tissue specimen between two slides before microscopic analysis. The specimen is placed on the flat on the first slide. The second slide is held at a right angle to the first and then dragged along the specimen, distributing it lengthwise along the first slide.

Staining technique: Staining is a technique used in microscopy to enhance contrast in a microscopic image. Stains and dyes are frequently used to highlight structures in microbes for viewing, often with the aid of different microscopes.

Suspension: A heterogeneous dispersion in which the dispersed phase consists of solid particles sufficiently large that they will settle out of the fluid dispersion medium under the influence of gravity.

Temporary Mount: Wet mount or temporary mount technique is used to study the movement and behavior of living microorganisms. In this method, a drop of water is placed over a slide and then the specimen is placed within it. After that covers it with a coverslip and observe under a microscope.

Transmission Electron Microscope: Is a microscope used to view thin specimens (tissue sections, molecules, etc) through which electrons can pass generating a projection image. The TEM is analogous in many ways to the conventional (compound) light microscope.

Unaided Human Eye: Naked eye, also called bare eye or unaided eye, is the practice of engaging in visual perception unaided by a magnifying, light-collecting optical instrument, such as a telescope or microscope, or eye protection. Vision corrected to normal acuity using corrected lenses is still considered "naked".

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