CENGAGE

Cengage EXAM CRACK Series®

GENERAL SCIENCE

For UPSC and State Civil Services Examinations

UPDATED EDITION

Helpful in **IAS Preparation**

prepmate®

General Science

for

Civil Services Examinations

CENGAGE

Australia • Brazil • India • Mexico • Singapore • United Kingdom • United States

CENGAGE

General Science for Civil Services Examinations

ISBN-13: 978-93-86858-52-8
ISBN-10: 93-86858-52-5

Cengage Learning India Pvt. Ltd.
418, F.I.E., Patparganj
Delhi 110092

Cengage Learning is a leading provider of customized learning solutions with office locations around the globe, including Australia, Brazil, India, Mexico, Singapore, United Kingdom and United States. Locate your local office at: **www.cengage.com/global**

Cengage Learning products are represented in Canada by Nelson Education, Ltd.

For product information, visit **www.cengage.co.in**

Contents

UNIT – III BIOLOGY

Preface

If you ever happen to be walking down the streets of places where preparation for Civil Services is done, it will not be uncommon for you to come across or make the acquaintance of 'several' starry eyed yet completely committed IAS aspirants. Yet, 'several' would be an understatement given the number that runs into lakhs! But when we say committed, we mean it; these young men and women are ready to sacrifice almost all their youthful follows including sleep, comfort and even a semblance of a normal life to achieve one goal—IAS!

Sadly, this dream remains a distant one for a large majority of these aspirants in spite of the endless hours of study and sleep forsaken nights. When we tried to unravel WHY, the responses were almost synchronous:

"The subject was so vast that there was too much to cover and I could never complete it."

"I read so much but could not retain it."

"I studied something but was quizzed on something else in the exam."

"I kept reading but did not attempt to solve the past year papers or give a mock exam."

"Subscribing to several sources of information/preparation such as a coaching class, the internet and books was futile; after all there are only 24 hours in a day."

"My almirah was full of too many books, but I could barely complete a few."

And while the candid answers stated above clearly gave us a challenging problem—we did not attempt to solve it. We instead focused on a holistic solution—the synchronizing of effort i.e. Learning and Positive Results!

It is with this aim that we—PrepMate collaborated with Cengage India—are continuously striving to develop a comprehensive learning model that is a combination of print and digital product so as to effectively address the issues that most aspirants grapple with.

About the Print–Digital Learning Model

The learning model initiates the process with a series of books targeted at cracking the UPSC exam. The books stand apart from others available because of the following unique features:

- We use a conceptual approach, simple language, explain concepts with diagrams, cite sufficient examples, pose pertinent questions in a reader friendly format—to ensure that the contents of these books can be read and assimilated in a time-bound manner.
- The content is specially designed taking into account the trend in UPSC exams in recent years. We have also included the previous years' questions (with solutions) after every chapter.

- The Practice Questions at the end of each chapter are exhaustive to provide sufficient preparation to crack the exams.
- We have tried to encapsulate all that is required to be learnt for a particular subject into a single book.

Usually, an aspirant purchases a book, but never gets a chance to contact the authors. We believe that the contact among aspirants and authors is important for learning and motivation of the aspirants. That is precisely why we have developed an application and a web portal to answer your queries and provide you with continuous support during your preparation.

It is through this digital component that we provide the following services:

1. Videos covering important and difficult topics
2. Answer writing practice sessions
3. Daily prelims quiz
4. Assistance in interview preparation
5. Regular updates
6. Daily current affairs
7. Monthly current affairs magazine
8. Radio news analysis
9. Educational videos
10. Previous years' papers and solutions
11. Free study materials

Looking forward to being your partner in the journey towards achieving your dream!

In case you have any specific queries or constructive feedback you can always share the same with us via e-mail at info@prepmate.in .

PrepMate

Acknowledgements

"We cannot accomplish all that we want to do without working together"

The complete UPSC learning module by Prepmate has been the culmination of more than a year of ideation and brain storming with a lot of people. It is only natural that we should gratefully acknowledge their valuable contribution sincerely. Nirmal Singla, Ramnik Jindal, Sharat Gupta, Subhash Singla and Vijay Singla—thank you for your continuous support and motivation.

We would also like to thank Maninder Mann, Rajinder Paul Singla and Sundeep Singh Garha who helped us in first conceiving and later developing the synergistic print–digital model of the project—without you we would be missing our competitive edge.

Implementation of strategy can more often than not prove challenging and the development of the digital component did prove to be tougher than we had envisaged. But our technical team was focused on enabling our dream and delivering the best and they surely did. With a specific mention to the testing of both the website and the application, we would like to thank Parth, Tanvir and Surabhi who did their job patiently and effectively in spite of the road blocks.

Our videos and books could not have been possible without the help of our graphics design team—Sandeep, Manjeet, Sukhjinder, Roshni and Uday toiled endlessly to ensure the best designed audio-visuals.

It is an understatement to state that the sourcing and reviewing of existing content and the generation of missing content was the most crucial part of this project and the backbone of our Learning Module. This would just not have been possible without our team of content contributors: Isha Gupta, Shelly Jindal, Gurdeep, Surabhi, Shantnu, Tanvir, Anmol, Kriti, Tanya, Sahil, Suraj and Dilshad, who left no stone unturned in their pursuit of excellence—your pivotal contributions are gratefully acknowledged.

We would like to extend a special thanks to our staff members Geeta, Jitender, Manoj and Pinki, who helped us in the most laborious job i.e. typing through the several manuscripts of our books—your contribution is sincerely appreciated.

It is imperative that we thank Isha Gupta, Shelly Jindal, Anjum Diwan, Rajesh Goel, Shikha Sharma and Ravinder Indoura, for their critical yet constructive feedback that identified and subsequently rectified the errors that crept in during the development process. We will never be able to thank them enough for this—you fortified the very foundation of our model.

We sincerely acknowledge the initiatives and support from the entire editorial team of Cengage India in the process of publishing this book.

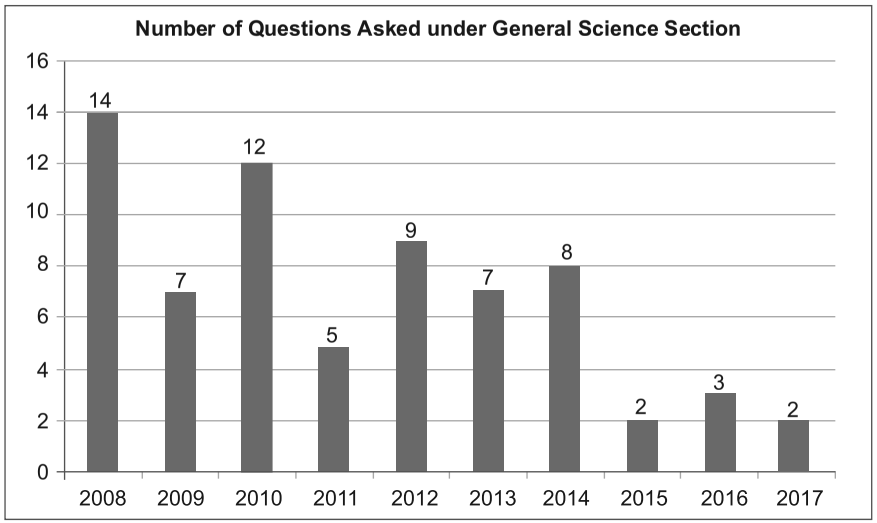
PrepMate

List of Videos

Chapter-wise Break up of Previous Year's Questions (Prelims)

Chapters	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	Total
PHYSICS											
1. Motion											0
2. Force and Laws of Motion					1					1	2
3. Gravitation											0
4. Work and Energy											0
5. Sound											0
6. Light I					1						1
7. Light II					1			1			2
8. Electricity											0
9. Magnetics Effects of Electric Current		1									1
10. Electromagnetic Radiation						1		2	2	2	7
11. Laser							1				1
CHEMISTRY											
1. Matter											0
2. Is Matter Around Us Pure?				1		2		1		1	5
3. Atoms and Molecules									1	1	2
4. Metals and Non-Metals						1				1	2
5. Chemical Reactions											0
6. Carbon and Its Compounds						1				1	2
7. Acids, Bases and Salts											0
BIOLOGY											
1. Cell: Unit of Life											0
2. Plant Diversity				1	1	1	1	1	1		6
3. Animal Diversity				2				1	1	3	7
4. Heredity and Evolution		1						1	1		3

Chapters	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	Total
5. Life Processes				2	1		2	1		1	7
6. Control and Coordination											0
7. Reproduction in Organisms	1			1	1	1					4
8. Why do We Fall Ill?	1	1	1	1	1			4		2	11
ASTRONOMY											
1. Our Universe			1			2	1		1	1	6
TOTAL	**2**	**3**	**2**	**8**	**7**	**9**	**5**	**12**	**7**	**14**	**69**



Unit – I

PHYSICS

Chapter 1

MOTION

In physics, motion is a change in position of an object over time. Motion of a body depends on the frame of reference. For instance, for the passengers in a moving bus, the roadside houses appear to be moving backwards. A person standing on the roadside perceives the bus as moving. However, a passenger inside the bus perceives the fellow passengers at rest.

If the position of a body is not changing with respect to a given frame of reference, the body is said to be at rest or stationary. In our example, a passenger inside the bus perceives the fellow passengers at rest.

An object's motion can change only when a force acts on the object. Further, the motion of a body is described in terms of displacement, distance, speed, velocity and acceleration. Let us understand these concepts.

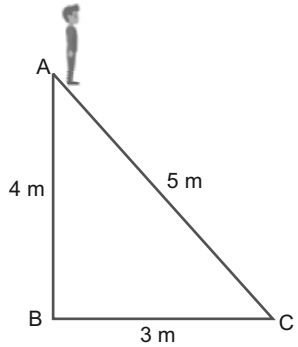
1 DISTANCE AND DISPLACEMENT

Distance

Distance is the total movement of an object without any regard to direction. It is defined as how much ground an object has covered from its starting point.

Displacement

It is defined as the change in position of an object. In other words, it is the shortest distance between the initial position and the final position. It is a vector quantity and thus, has both a direction and a magnitude.



Consider the given figure which shows a person travelled 4 m from Point A to Point B and then travelled 3 m from Point B to Point C. The total distance travelled by the person = 4 m + 3 m = 7 m.

On the other hand, the displacement is the distance between Point A and Point C, which is 5 m.

Further, he travels 5 m from Point C to Point A. In this case, the total distance travelled = 4 m + 3 m + 5 m = 12 m, but displacement is 0 because the final position and the initial position of the person is the same.

Difference Between a Vector Quantity and a Scalar Quantity

The main difference between a vector quantity and a scalar quantity is that a vector quantity has both magnitude and direction, whereas a scalar quantity has only magnitude and no direction.

For instance, the measurement of temperature of an object is a scalar quantity; the measurement of the increase or decrease in the temperature of the object is a vector quantity.

When a vector is represented in a diagram, the length of a vector depicts magnitude. The arrow, on the other hand, shows the direction.

2 UNIFORM AND NON-UNIFORM MOTION

Uniform motion is the kind of motion in which a body covers equal distances in equal intervals of time, even if we consider very small intervals of time.

For instance, if a bicycle moving with the uniform motion has a speed of 5 m/s, it means that the bicycle covers 5 metres in each second.

On the other hand, non-uniform motion is a motion in which a body covers unequal distances in equal intervals of time.

3 RATE OF MOTION (SPEED)

The rate of motion or speed of an object is calculated by dividing the distance travelled by the object in unit time. The unit of distance is metre, kilometre, etc., and the unit of time is hour, second, etc. Therefore, the unit of speed is metre/second or kilometre/hour.

What Is SI Unit?

The International System of Units (abbreviated SI from Systeme International, the French version of the name) is a scientific method of expressing the magnitudes or quantities of natural phenomena.

There are seven base units in the system, from which other units are derived. The seven base units are:

SI Base Units:

1. The metre (abbreviation, m) is the SI unit of displacement or length.
2. The kilogram (abbreviation, kg) is the SI unit of mass.
3. The second (abbreviation, s or sec) is the SI unit of time.
4. The kelvin (abbreviation, K), also called the degree Kelvin (abbreviation, °K), is the SI unit of temperature.
5. The ampere (abbreviation, A) is the SI unit of electric current.
6. The candela (abbreviation, cd) is the SI unit of luminous intensity.
7. The mole (abbreviation, mol) is the SI unit of material quantity.

The other SI units are derived from these units.

$$\text{Speed} = \frac{\text{Distance Travelled}}{\text{Time taken}}$$

For instance, let us say that a person travels 200 km in 5 h. Then, the speed of the person is $\frac{200}{5} = 40$ km/h.

4 SPEED WITH DIRECTION (VELOCITY)

Velocity is speed with a direction, while speed does not have a direction. Speed is a scalar quantity. On the other hand, velocity is a vector quantity. Thus, when we specify velocity, we must specify the magnitude (the speed) and the direction of travel. For example, a person is driving his car at a speed of 100 km/h in the south direction.

This is analogous to the difference between distance (a scalar quantity) and displacement (the distance with direction.)

Change of Velocity

A change in speed or a change in direction, or a change in both speed and direction, means that the object has a change in velocity. For instance, when a person driving his car at 100 km/h (the speed) in the south direction either reduces or increases speed or changes direction of travel, there will be change in velocity.

Velocity of an Object Moving in Circular Path

Velocity of an object moving in a circular path is constantly changing because in a circular path, the body continuously changes its direction.

Final and Initial Velocity

Initial velocity of an object means the velocity of the object at the starting reference point. The initial velocity is denoted by '*u*'. Final velocity of the object is given as the velocity at the ending reference point. The final velocity is denoted by '*v*'.

In some cases, both initial and final velocities can be zero. For instance, when a car starts journey from rest and ends its journey at rest. In other cases, initial velocity can be more than zero and the final velocity is zero. For example, when a car stops after applying the break, its initial velocity is greater than zero, but the final velocity is zero.

Rate of Change in Velocity (Acceleration)

Acceleration is the rate at which an object changes its velocity. In other words, acceleration is the change in velocity in a period of time. Thus, acceleration of an object is based on both velocity and time. The SI unit of velocity is metre/second, and the SI unit of time is second.

Thus, the SI unit of acceleration is $\frac{\text{metre/second}}{\text{second}}$ = metre/second^2 or m/s^2 or ms^{-2}.

Mathematically, acceleration is calculated with the following formula:

$$a = \frac{v - u}{t}$$

where a stands for acceleration, v stands for final velocity, u stands for initial velocity, and t stands for time taken to reach the final velocity from the initial velocity.

Let us read the following example to understand the concept of acceleration. When you drive a car, you can accelerate it till maximum velocity as per the speed limit permitted in the city. Let us presume that the speed limit is 60 km/h.

If you press the accelerator hard, you may be able to attain 0 to 60 km/h in about 7 s. If you press it gently, you may attain 60 km/h in 14 s.

In both the cases, whether you are pressing the accelerator of your car gently or hard, you are experiencing acceleration. If you decrease the time to change speed from 0 to 60 km/h, the acceleration is greater. The moment you attain 60 km/h and keep a constant speed, your acceleration is zero.

As acceleration is based on velocity, which is a vector quantity, so change in direction also brings acceleration. If the car turns, an acceleration occurs towards the new direction. In the above example, we can call the forward acceleration of the car a linear acceleration. Acceleration on account of change in direction is called non-linear acceleration.

Let us suppose that you are required to reduce speed on account of heavy traffic. If the speed of the car decreases, this leads to negative acceleration, also called **deceleration**. Mathematically, there is no separate formula for deceleration: both are change in velocity.

Acceleration of a Body Moving in a Circular Direction

If a body is moving in a circular path, there is a continuous change in its velocity due to change in direction. Consequently, there is continuous change in acceleration.

Practice Questions

1. Which one of the following is **not** a vector quantity?
   (a) Speed
   (b) Velocity
   (c) Displacement
   (d) Both velocity and displacement

2. Which one of the following relation between distance and displacement is correct?
   (a) Displacement can be greater than distance.
   (b) Distance is always equal to displacement.
   (c) Distance can be greater or equal to displacement.
   (d) Displacement is always less than distance.

3. If we throw a ball upwards as high as we can, which one of the following physical quantity remains constant?
   (a) Displacement
   (b) Speed
   (c) Acceleration
   (d) Velocity

4. Which of the following factor can lead to continuous change in velocity of a moving body?
   (a) Movement in a straight line
   (b) Movement in a circular path
   (c) Movement at fast speed
   (d) Movement at slow speed

5. What will happen to the acceleration of a moving object, if the time taken to attain a particular velocity is reduced?
   (a) The acceleration will increase.
   (b) The acceleration will reduce.
   (c) The acceleration will remain constant.
   (d) The acceleration will either increase or decrease.

☑ ANSWER KEYS

Practice Questions

1. (a)	2. (c)	3. (c)	4. (b)	5. (a)

Chapter 2

Force and Laws of Motion

Force refers to push or pull upon an object which results in the change

- of motion of that object or
- of direction of the motion or
- of shape of the object.

Force is a result of interaction between one object with another object. Here, both the objects experience force. For instance, when a person presses a ball with both the hands, then both the ball and the hands experience force.

Force can be of two types:

1. **Balanced force:** When two forces act from two opposite directions upon an object, and the forces are equal in magnitude, then they are regarded as balanced forces. For example, in the game of tug of war, two teams try to pull each other but both the teams do not experience any movement. This is because the teams are putting force which is opposite in direction and equal in magnitude.

   Let us take another example, suppose you want to move a heavy box. You try to push the box but it does not experience any movement. This is because the force exerted by you is balanced by the force of friction experienced by the box on account of contact with floor surface.

   What is force of friction and how it can be reduced?

   Friction arises when two surfaces are in contact with each other. In the earlier example, the two surfaces in contact are bottom of the box and surface of the floor. Force of friction can be decreased by making surfaces in contact smooth. This can be done by application of oil or grease on the surface. It can also be decreased by reducing the area of contact between surfaces such as through the use of ball bearings in bicycle, machinery, etc. Ball bearings in a bicycle reduce the area of contact between wheel and axle and thus reduce the friction experienced in running a bicycle.
2. **Unbalanced force:** When two forces act from two opposite directions upon an object, and the forces are not equal in magnitude, then they are known as unbalanced forces. For example, in the game of tug of war, the moment one team is able to pull the other team towards itself; the unbalanced force comes into play. Here, one team was able to pull another team because one team applied larger force than that applied by the other team.

1 GALILEO'S INCLINED PLANE EXPERIMENT

Galileo observed that when a marble rolls down an inclined plane, its velocity increases under the force of gravity and attains a definite velocity by the time it reaches the bottom of the plane.

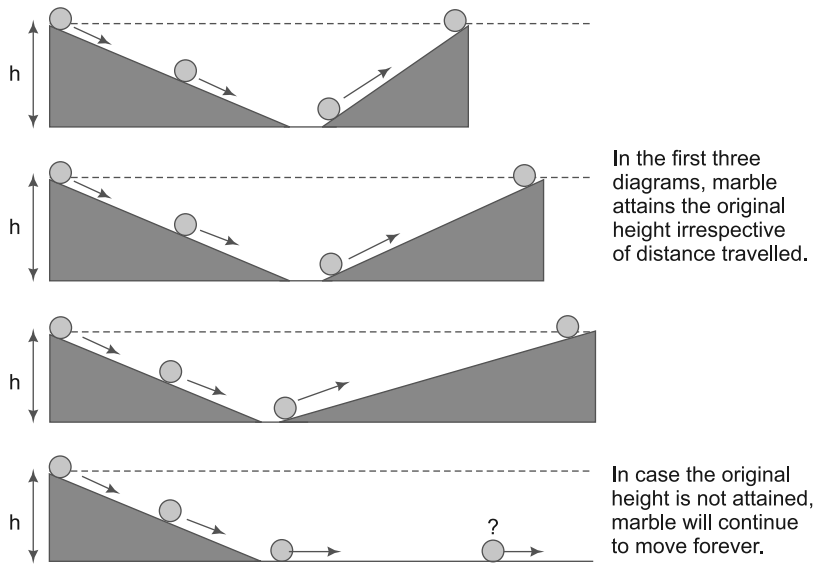
Galileo argued that when the marble is released from a height, it would roll down the slope and go up on the opposite side slope to the same height from which it was released. If the inclinations of the planes on both the sides are equal, then the marble will travel the same distance as it covered while rolling down.

If the angle of inclination of the right-side plane is decreased, then the marble would travel further distance till it reaches the original height from which it started to roll down. If the right-side plane is made horizontal (that is, the slope is reduced to zero), then the marble would continue to travel forever—trying to reach the same height from which it was released.

Explanation

Galileo argued that as the marble rolls down an inclined plane, its velocity increases under the force of gravity. Gravitational force is not balanced by any other force. Consequently, marble experiences motion.

As marble rolls upwards, it moves against gravity utilising the force generated while rolling down. It will roll upwards till the force generated on account of rolling down is balanced by the force required to climb upwards. Thus, the marble will attain exactly the same height from which it started to roll down.



In practical situations, there is also a force of friction. **Friction** is a force that holds back the movement of a sliding object. It exists everywhere when objects come into contact with some other object. Thus, in practice the marble stops after travelling some distance due to force of friction. This force of friction is on account of contact with the surface. The effect of the frictional force may be minimised by using a smooth marble and a smooth plane.

2 LAWS OF MOTION

After studying Galileo's ideas on motion and force, Newton came up with three fundamental laws that govern the motion of objects. These laws are known as Newton's laws of motion.

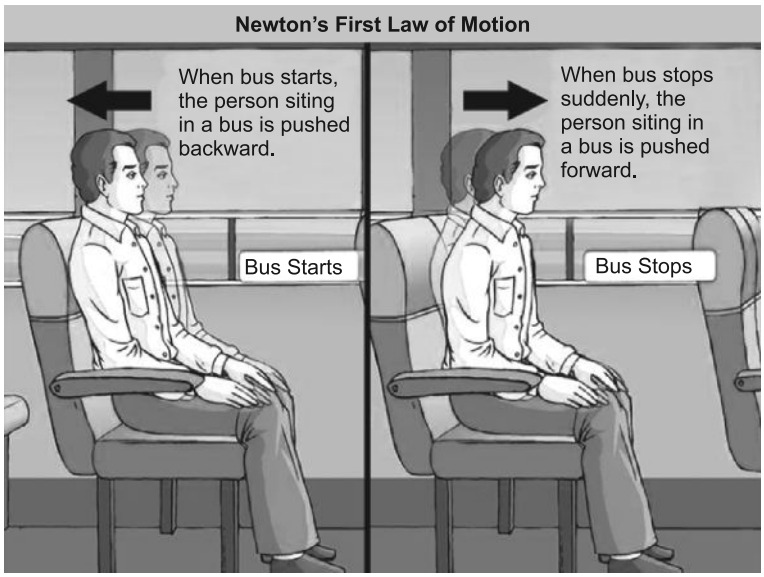
First Law of Motion

The first law of motion states that an object at rest remains in the state of rest and the object in motion remains in the state of uniform motion in a straight line until acted upon by an external force. In other words, it can be said that there has to be a cause for an object to bring change in its state or motion. An external force has to come into play for an object to change its motion or direction.

The tendency of an object to stay at rest or keep moving with the same velocity in the same direction is known as **inertia**. This is why the first law of motion is also known as the law of inertia.

The best example to explain inertia is that of a bus. It is often observed that a person standing in the bus is pushed forwards when the driver applies the breaks suddenly. This is because of Newton's first law of motion or the law of inertia. The body of the person tends to remain in motion because of its inertia, while the bus has stopped.

An opposite experience takes place when the bus suddenly starts moving forward, and as a result, the person standing in the bus is pushed backwards. This happens because the bus gets in motion, while the body of the person continues to stay at rest.



Similarly, when the bus turns towards the right side, the person standing in the bus is pushed towards the left side and vice versa.

Inertia and mass

The examples suggest that all the objects have a tendency to resist the change in their state of motion or direction.

We all know that pushing an empty box is much simple as compared to pushing a box full of heavy objects. Similarly if we kick a football, it might fly away, but if we kick a stone of the same size with the same force we might end up hurting our foot. This happens because heavier objects or objects with more mass have more inertia. The inertia of an object can be measured by its mass. Therefore, the objects with higher mass have higher resistance to change their state of motion. Thus, the relationship between inertia and mass of an object can be defined as: the higher the mass of an object, the more is its inertia and vice versa.

Second Law of Motion

The first law of motion states that an object changes its velocity, direction or both when acted upon by an external force. And the second law of motion states that the acceleration of an object depends on the force applied on it and the mass of that object.

As the force applied on an object increases, the acceleration experienced by the object also increases. As the mass of an object increases, the acceleration experienced by the object decreases. Thus, acceleration experienced by an object is directly related to the force acting upon that object and inversely related to the mass of that object.

Momentum is a property of an object, which combines the velocity and the mass of an object. The momentum of an object can be defined as the product of its mass (m) and velocity (v).

$$p = m \times v$$

where p stands for the momentum, m stands for the mass, and v stands for the velocity.

As the momentum consists of both velocity and mass, the SI unit of the momentum is kilogram-metre per second. Since the application of an unbalanced force brings a change in the velocity of the object, it is therefore, clear that a force also produces a change of momentum.

Let us consider a situation in which persons have to push a car. If one or two persons give the car random pushes (unbalanced force), then the car will move a bit. However, if the persons keep on pushing the car continuously, then gradually the car will attain speed. This means that the change in momentum is determined not only by the magnitude of force but also on the time for which the force is exerted upon the object.

Thus, it can be concluded that the rate at which the momentum of the object is changed depends on the force necessary to change the momentum of an object. Therefore, we can conclude that the second law of motion states that the rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of motion.

$$F = \frac{\text{Change of momentum}}{\text{time}} = \frac{\text{Final momentum} - \text{Initial momentum}}{\text{time}}$$

Mathematical formulation of second law of motion

Let us consider an object with mass (m) which moved at an initial velocity (u) and a final velocity (v) after a certain period of time (t).

We know that momentum, p = mass × velocity

Thus, the initial momentum, p_1 = mass × initial velocity = $m \times u = mu$

The final momentum, p_2 = mass × final velocity = $m \times v = mv$

Change in momentum = $p_2 - p_1 = m \times v - m \times u = m \times (v - u)$

We have learnt that the rate of change of momentum per unit of time is proportional to the applied force. Thus,

Applied force, $f \propto m \times \frac{(v - u)}{t}$

$F \propto m \times a$ (we have learnt that acceleration is the rate of change of velocity per unit of time)

$f = k \times m \times a$ (where k is the constant of proportionality)

The SI units of mass and acceleration are kg and ms^{-2} respectively. Thus, the SI unit of force is kg × m s^{-2} or newton.

If we apply a force of 1 N on a mass of 1 kg, the acceleration attained is 1 m s^{-2}. Thus, we can conclude that value of $k = 1$. Therefore, $f = m \times a$.

We can conclude that the force acting on an object is the product of its mass and the acceleration attained by it.

Let us consider an example to understand the application of this relation. Have you ever noticed a fielder pulling his hands backwards while catching a leather ball?

When a cricket ball is hit with ample force, it has a considerable momentum.

In case you try to catch a leather ball without moving your hands backwards, your hands would experience greater force and thus, pain. This is because the time taken to change the momentum of the ball is very short. (In case the value of t is very small in the formula $f = \frac{m \times (v - u)}{t}$, the value of force increases.)

In case, the hands are moved in the direction opposite to the direction from where the ball is coming, the time taken to stop the ball increases and thus the force applied on hands reduces. Thus, the hands are saved from injuries.

While holding a catch, fielder pulls his hands backward in order to reduce the force acting on hands

(In case the value of t is large in the formula $f = \frac{m \times (v - u)}{t}$, the value of force reduces.)

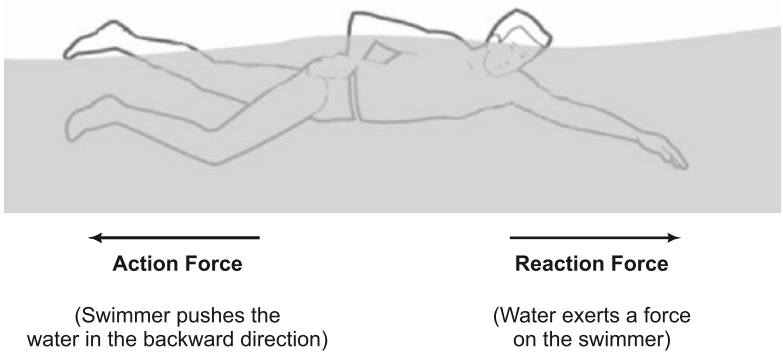
Third Law of Motion

In the previous two laws, we learned how an external force brings change in the state of motion of an object and what are the methods to determine the amount of that force.

The third law of motion states that 'for every action there is an equal and opposite reaction'. In other words, when one object exerts some force upon another object, then the second object simultaneously exerts the equal amount of force on the first object. The size of the force applied is the same on both the objects. The direction of the force is, however, opposite.

According to Newton, whenever two objects interact with each other, they exert some force upon each other. For example, when you sit on a chair, you put a downward force on the chair and the chair puts an upward force on your body. Here, we can see that there are two forces resulting from this interaction—a force on the chair and a force on the body. These two forces are known as action and reaction forces. They always come in pair and never act as a single force.

Let us take another example. Have you ever noticed that a swimmer pushes the water backwards to swim in the forward direction? When the swimmer pushes the water backwards, the force applied by the swimmer on water is the action force. In return, water pushes the swimmer in the forward direction. The force applied by water on the swimmer is the reaction force. Both the action and reaction forces are in opposite directions.



It is important to note that even though the action and reaction forces are always equal in magnitude, these forces may not produce accelerations of equal magnitudes. This is because the action and reaction forces apply on different objects, and these objects may have a different mass. For example, when you jump, your legs apply a force to the ground, and the ground applies an equal and opposite reaction force that propels you into the air. Even though both the ground and your body experiences equal force, your body experiences larger acceleration because of far lesser mass than that of the ground.

Practice Questions

1. Which of the Newton's law of motion states that 'for every action, there is an equal and opposite reaction'?
   (a) First law of motion
   (b) Second law of motion
   (c) Third law of motion
   (d) This was stated by Albert Einstein, not Newton.

2. When the swimmer pushes the water backwards, the force applied by the water will be in
   (a) Forward direction
   (b) Backward direction
   (c) No force will be applied by water.
   (d) Data is insufficient, hence cannot be concluded.

3. Which one of the following is a vector quantity?
   (a) Momentum
   (b) Speed
   (c) Distance
   (d) None of the above

4. A car is running on a road at a uniform speed of 60 km/h. Assuming that force of friction is absent, the net resultant force on the car is:
   (a) Driving force in the direction of car's motion.
   (b) Resistance force opposite to the direction of car's motion.
   (c) An inclined force.
   (d) Equal to zero.

5. If a light body and a heavy body have equal momentum, then
   (a) The lighter body has greater velocity than the heavier body.
   (b) The lighter body has lesser velocity than the heavier body.
   (c) The velocity of the lighter body is equal to the velocity of the heavier body.
   (d) The velocity of both the bodies are independent of momentum.

6. A person sitting in an open car moving at constant velocity throws a ball vertically upwards in air. If effect of air resistance is neglected, the ball will fall
   (a) Exactly in the hands of the person.
   (b) Outside the car.
   (c) In the car behind the person.
   (d) In the car ahead of the person.

PERFECTING PAST PRELIMS

1. A person is sitting in a car which is at rest. The reaction from the road at each of the four wheels of the car is *R*. When the car runs on a straight level road, how will the reaction at either of the front wheels vary? **(2008)**
   (a) It will be greater than *R*.
   (b) It will be less than *R*.
   (c) It will be equal to *R*.
   (d) It shall depend on the material of the road.

2. Ball bearings are used in bicycles, cars, etc., because **(2013)**
   (a) The actual area of contact between the wheel and axle is increased.
   (b) The effective area of contact between the wheel and axle is increased.
   (c) The effective area of contact between the wheel and axle is reduced.
   (d) None of the above statement is correct.

ANSWER KEYS

Practice Questions

1. (c)	2. (a)	3. (a)	4. (d)	5. (a)
6. (a)				

Perfecting Past Prelims

1. (a)	2. (c)	

Unit – II

CHEMISTRY

Chapter 1 MATTER

Matter is anything that occupies space and has mass. In other words, matter has both mass and volume. It can be in any form such as solid, liquid or gas. For instance, the air we breathe, the food we eat, the water we drink, plants, stars, stones, clouds or a particle of sand are all matter.

Scientists have classified matter based on their physical and chemical properties. In this chapter, we will study about physical properties of matter. We will discuss about the chemical properties in subsequent chapters.

1 WHAT IS MATTER MADE UP OF?

For a long time, scientists were unable to decide as to what really matter was made up of. Two different views on the nature of matter emerged. One believed that matter was continuous such as a piece of stone or a block of wood, whereas the other believed that matter was made up of particles such as sand. This debate existed for a long time. Later on, scientists were able to prove that matter is made up of particles.

Experimental Support

Let us take salt and water. We know that both are matter. We try to dissolve salt in water. We notice that salt completely disappears into water. Also, if we look closely, we will further notice that the level of water in the container does not change. A chunk of salt contains many salt crystals. Each crystal is made up of small salt particles. The particles keep breaking from each other and spread evenly among the interparticle spaces of water. Hence, the level of water does not change.

From the above example, we can clearly make out that matter is made up of particles.

2 CHARACTERISTICS OF PARTICLES OF MATTER

1. **Size of particles:** The particles of matter are very small in size. These particles can be so tiny that we cannot even see them with our naked eye. Let us perform an activity to understand how small particles of matter can be!

   Have you ever played Holi with coloured water? A small concentrate can add colour to many buckets of water. Thus, we can conclude that there must be numerous tiny particles in just one small pouch of concentrate, which keep on dividing into smaller and smaller particles.

2. **Particles of matter have space among them:** This can be concluded by observing the solubility of one matter into the other. Particles of one type of matter spread evenly into the other matter. This shows that there exists some space between the particles of matter. For example, salt crystals when dissolved in water disappear completely.
3. **Particles are continuously moving:** Particles of matter are continuously moving. This is because they possess kinetic energy and this energy aids their movement. For example, smell of food travels in air. This is because the gaseous particles present in food travel in the surrounding air on account of the energy possessed by them.

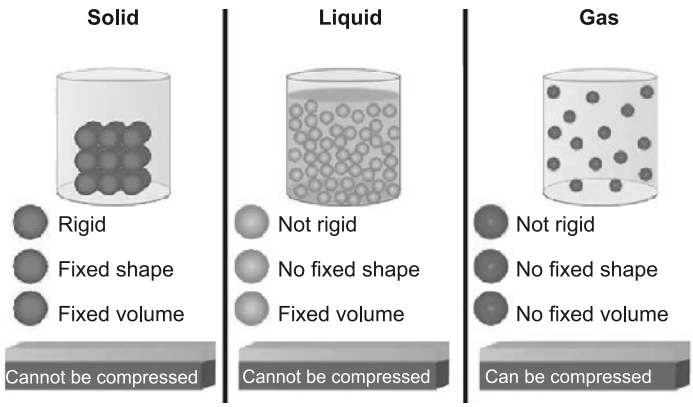
   When the temperature of particles increases, they travel faster. This is because the increase in temperature of the particles increases their kinetic energy. Movement of particles causes intermixing of particles. Rise in temperature of particles results in faster intermixing.

   When the particles of two different matters intermix on their own, the process is called diffusion. For instance, the air around us is on account of diffusion of multiple gases. As the temperature of gases rise, the process of diffusion becomes faster.
4. **Particles of matter attract each other:** Particles of matter are acted upon by an interparticle force of attraction which binds them together. The strength of this force varies from matter to matter. The matter having a weak force is easier to break as compared to the one which has a strong force of attraction. To break any matter, we need to overcome this force.

   For example, it is easier to break a chalk than to break a nail. This is because the inter-particle force of attraction among the particles of iron nail is much higher as compared to the chalk. The interparticle force of attraction and the kinetic energy that exists among the particles of matter determine the physical state of any matter, i.e. solid, liquid or gas.

3 STATES OF MATTER

We have already discussed that there exists kinetic energy and a force of attraction among the particles of matter and their combined effect determine the state of matter. Based on this, the matter can be classified into three states: (i) solid, (ii) liquid and (iii) gas. This classification arises mainly because of the variations among the characteristics and the force of attraction that exists among the particles.



1. **Solid state:** Solids have definite shapes, distinctive boundaries and fixed volumes. They are not easily compressible; they have a tendency to maintain their shape. When subjected to an external force, they may break but it is very difficult to alter their shape. This is because the particles of solid have very less space between them and the movement among the particles is almost impossible. A single particle is locked at its place by other particles surrounding it. Consequently, solids are rigid in shape.
2. **Liquid state:** Liquids take the shape of the container in which they are poured. Thus, liquids have no definite shape or distinctive boundaries but have fixed volume. Liquids are not easily compressible. Liquids change shape and, thus, are not rigid. We observed earlier that solids and liquids can diffuse in liquids. The gases from atmosphere can also diffuse in water. These gases are essential for the survival of aquatic animals. Thus, we can say that all three states of matter can dissolve in liquids.

   The rate of diffusion in liquids is more than that of solids, but less than that of gases. This is because the particles of liquid have much more space among them as compared to those in solid. On the other hand, the particles in liquid have less space among them as compared to those in a gas.
3. **Gaseous state:** Gases take the shape and volume of the container they occupy. This suggests that gases have no distinctive shape nor do they have any fixed volume. Gases are highly compressible as compared to liquids and solids. The particles of a gas have such a large space between them that they do not form any shape until they are filled in some container.

   The liquefied petroleum gas that we use in our households for cooking food is a compressed form of gas. Because of the high compressibility, high volumes of gas can be easily compressed into a cylinder and conveniently transported.

Can Matter Change Its State?

We know that matter exists in three physical forms: solid, liquid and gas. These states of matter are interchangeable. Solid can be changed into liquid and vice versa, liquid into gas and vice versa, and even solid state can directly change into gaseous state and vice versa. There are two ways in which a matter can change its state:

Change in Temperature

Change in state of matter takes place on account of change in temperature. With the increase in temperature, the kinetic energy among the particles increases. Due to increase in kinetic energy, the particles start vibrating vigorously. The kinetic energy among the particles overcomes the force of attraction among them. As a result, the particles are displaced from their positions and begin to move more freely.

Solid to liquid: When the temperature of particles is raised for some time, there comes a stage at which the solid object melts to liquid form. The temperature at which the solid starts converting into liquid is known as the melting point of that solid. For instance, the melting point of ice is 0°C. Depending upon the nature of solid, the melting point is different for different objects.

Latent heat: If we continue to add heat even when the melting point of an object is attained, the temperature of an object will remain the same till the object completely converts into liquid. For instance, if we continue to apply heat, temperature remains constant till all the ice melts into water. If the temperature remains unchanged, then where does this additional heat go?

The extra heat energy is consumed in overcoming the interparticle force of attraction and, thus, changing the state of matter. The heat energy which does not raise the temperature of an object but only changes the state of matter is known as the latent heat. 'Latent' literally means 'hidden' or which is not apparent because it does not raise the temperature of an object. On account of latent heat, we can conclude that at the same temperature water particles have higher energy as compared to the particles of ice.

In the above case, the heat energy required to overcome the force of attraction among the particles of solid to convert it into its liquid form is called latent heat of fusion.

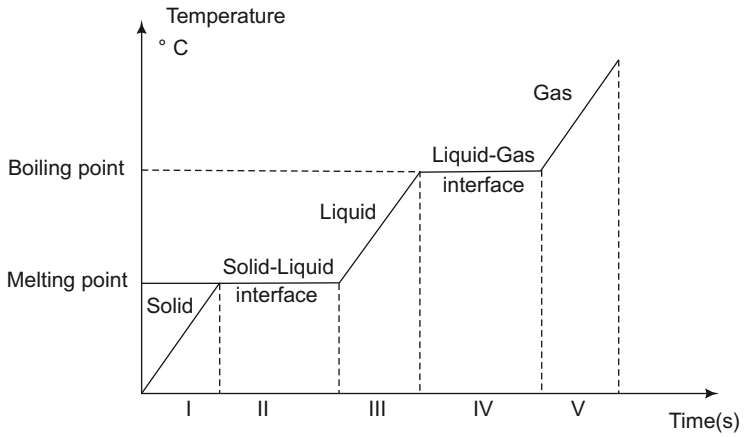
Liquid to gas: If we continue to supply heat to the water particles, they start vibrating at a faster rate. At a particular temperature, a point is reached where the particles gain so much energy that they are able to overcome the force of attraction and start moving freely. At this temperature, the liquid starts converting into gas. The temperature at which an object starts boiling is known as the boiling point of that object. For instance, the boiling point of water is 100°C.

Moreover, if we continue to apply heat once the boiling point has been attained, then the water will continue to convert into water vapour or steam at the same temperature. This is because the particles in water absorb extra energy in the form of latent heat of vaporisation.

Gas to liquid: Vapours can also be converted back into liquid form. For instance, when rising water vapours (steam) encounter a cold surface they lose heat and convert back to liquid form. This process, unlike vaporisation, involves loss of heat. This process of conversion of gas (vapours) into liquid (water droplets) is called condensation and the heat energy released during the conversion is called latent heat of condensation.

Solid to gas: If a matter changes directly from solid state to gaseous state without changing into liquid form, the process is known as sublimation. Naphthalene balls used in households to protect clothes from larvae of moth exhibit sublimation. Sudden change of temperature can also lead to sublimation. On the other hand, if the matter changes directly from gaseous state to solid state without changing into liquid form, the process is known as deposition. Gaseous CO_2 directly converts to dry-ice when cooled to –78.5°C.

Original State	Change To	Name
Solid	Liquid	Melting
Liquid	Solid	Freezing
Liquid	Gas	Boiling
Gas	Liquid	Condensation
Solid	Gas (Skipping Liquid Phase)	Sublimation
Gas	Solid (Skipping Liquid Phase)	Deposition



Change in pressure

We know that the difference in various states of matter exists because of the prevailing distance between the particles of that matter. What happens if we put pressure on the particles of matter? Particles of matter can be brought together by applying pressure on them. Applying pressure and reducing the temperature of a gas can liquefy the gas. Liquefaction is the process of conversion of gas to liquid.

The process of conversion of matter from its gaseous or solid form (both ways) to its liquid form is called liquefaction.

Similarly, a gas can be directly converted into solid by reducing pressure. This process of conversion of gas directly into solid is called deposition.

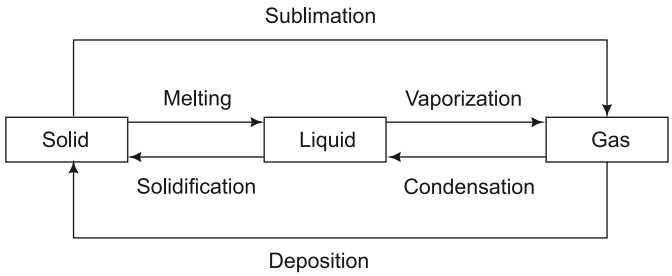
Let us take the example of carbon dioxide (CO_2). When stored under high pressure, CO_2 turns into solid CO_2. And when the pressure is decreased to 1 atmosphere, solid CO_2 converts into gaseous state without changing into liquid state. As carbon dioxide gas directly converts to solid form, it is called dry-ice.

Atmosphere is a unit to measure the pressure exerted by gas. We have learned that unit of pressure is pascal (Pa).

1 atmosphere = 1.01×10^5 Pa

The pressure of air in the atmosphere is called atmospheric pressure. The atmospheric pressure at sea level is 1 atmosphere and is taken as the normal atmospheric pressure. As we go upwards, the pressure of air above us reduces.

Thus, we can conclude that both temperature and pressure play an important role in determining the state of matter, i.e. whether it will be solid, liquid or gas.



Evaporation

The phenomenon of change of water into vapours at any temperature below the boiling point is known as evaporation.

Have you ever noticed that wet clothes dry up without the water reaching the boiling point? When the water is left uncovered in a bucket, it slowly changes into vapour. Why does this happen?

This happens because particles of liquid at the surface tend to possess higher kinetic energy and are less bound by interparticle force of attraction. As a result, these particles are able to break the interparticle force of attraction and change into vapour.

Factors Affecting Evaporation

The following factors help in increasing the rate of evaporation:

- **Increase in surface area:** Increase in surface area, increases the rate of evaporation. For example, if we keep wet clothes in folded form, they take longer time to dry. On the other hand, if we spread the clothes, they dry early.
- **Increase in temperature:** Particles gain more kinetic energy with the increase in temperature (heat) and they convert into vapour form faster.
- **Decrease in humidity:** Humidity refers to the amount of water vapours present in the atmosphere. If the amount of water vapours present in the air is high, the rate of evaporation decreases and vice versa.
- **Increase in wind speed:** Increase in wind speed shifts the water vapours present in the surrounding air and brings in dry air to accommodate more water vapours. Moreover, high speed of wind adds energy to surface water particles and sets them free.

How does evaporation reduce temperature?

Particles of water need heat to increase their kinetic energy in order to evaporate. Thus, the particles at surface absorb heat from their surroundings. This absorption of heat energy from the surrounding reduces the temperature. Thus, evaporation leads to cooler surroundings.

For example, people sprinkle water on the roof or open ground on a long sunny day. Water absorbs the heat from the ground and evaporates, cooling the ground.

It is advised to wear cotton clothes in summers because cotton is a good absorbent of water. It helps absorb the sweat from our body. The sweat then evaporates leaving a cooling sensation.

Why do we see water droplets on the surface of a glass containing ice-cold water?

This happens because the water vapours that are present in the surrounding air come in contact with the surface of the cold glass and lose their energy. As a result, the water vapours change into water droplets and appear on the surface of the glass.

Plasma

Plasma is considered the fourth state of matter. It consists of particles in the form of ionised (positively or negatively charged) gases. High temperatures are required to break the bonds and free the electrons from the particles, making the particles ionised. As plasma is formed at high temperatures, it is usually very hot. Stars (including the sun) are mostly made of plasma, which makes them glow.

In our day-to-day life, the fluorescent tubes and neon signboards consist of plasma. The gas present in them gets ionised when electricity flows through it, which makes them glow. The colour of plasma depends on the nature of the gas. The fluorescent tubes are usually filled with helium and neon signboards are filled with neon gas.

Relation Between Celsius, Kelvin and Fahrenheit

There are three type of units used to measure temperature namely Kelvin (K), Celsius (C) and Fahrenheit (F).

Relation between Kelvin and Celsius is a follows:

$$K = C + 273$$

Relation between Celsius and Fahrenheit is as follows:

$$F = 9/5(C) + 32$$

Practice Questions

1. During summer, water kept in an earthen pot becomes cool because of the phenomena of:
   (a) Diffusion
   (b) Evaporation
   (c) Osmosis
   (d) Transpiration
2. The rate of evaporation decreases with
   (a) Increase in humidity.
   (b) Increase in temperature.
   (c) Increase in wind speed.
   (d) Increase of surface area.
3. Amount of energy required to change liquid to gas without any change in temperature is termed as:
   (a) Latent heat of fusion.

(b) Latent heat of vaporisation.
(c) Heat capacity.
(d) Specific heat capacity.

4. The temperature at liquid–gas interface:
(a) Increases with addition of heat.
(b) Decreases with the addition of heat.
(c) Remains constant.
(d) Has no fixed pattern of change.

5. Consider the following statements:
1. Change of matter from solid to liquid state directly is known as sublimation.
2. Change of matter from gaseous to solid state directly is known as deposition.
Which of the following statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

6. Consider the following statements:
1. The constituent of plasma is super-heated uncharged matter.
2. Plasma finds application in nuclear fusion reactors.
Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

7. Consider the following statements:
1. The unit of pressure is N/m^2.
2. The pressure of air decreases with an increase in height.
3. The pressure of water decreases with increase in depth.
Which of the statements given above is/are correct?
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

8. Which of the following are used to change the state of matter?
1. Variation in temperature
2. Variation in pressure
3. Variation in mass of the substance
Select the correct option from the codes given below:
(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

9. Consider the following statements:
1. The interparticle spaces are least among solids.
2. Liquids have no fixed shape and volume and are nonrigid.
3. The interparticle force of attraction is weakest among gases.
Select the correct option from the codes given below:
(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

☑ ANSWER KEYS

Practice Questions

1. (b)	2. (a)	3. (b)	4. (c)	5. (b)
6. (b)	7. (a)	8. (a)	9. (c)	

Unit – III

BIOLOGY

Chapter 1 Cell: Unit of Life

All the organisms are made up of cells. A cell is called the fundamental unit of life because it is capable of existing on its own and performing all the functions which are necessary for a living being. Unicellular (single-celled) organisms such as amoeba are capable of independent existence which shows the cell's capability to exist independently. Cell is the smallest unit of life.

1 DISCOVERY OF CELL

In 1665, Robert Hooke discovered cell for the first time. He listed the following observations regarding cells:

1. All living organisms are composed of cells. Thus, cell is the fundamental unit of life.
2. All new cells come from the pre-existing cells.

The shape and size of the different type of cells vary and it is related to the specific function they perform. In some cases, the shape of the cell could be more peculiar than the other type of cells (like the nerve cells have a typical shape).

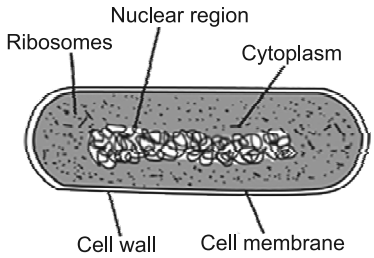
Each living cell has the capacity to perform certain functions that are characteristic to all living forms. Just like human body has different organs to perform different functions, cell has different divisions to perform different tasks, and these divisions are known as cell organelles. Each organelle performs different task. All cells have the same organelles no matter what organism they are found in or what function they have to perform.

2 TYPES OF CELLS

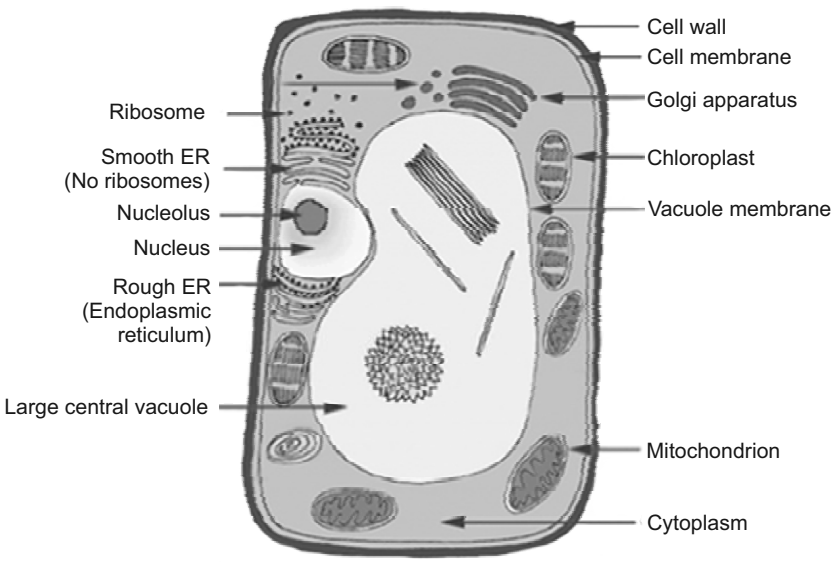
Cells can be divided into two types, which are as follows:

1. **Prokaryotic cells:** 'Pro' refers to primitive or primary and 'karyote' refers to nucleus. These cells can perform limited functions. Due to the absence of membrane, constituents of cell are not well defined. For example, bacteria, blue green algae, etc.

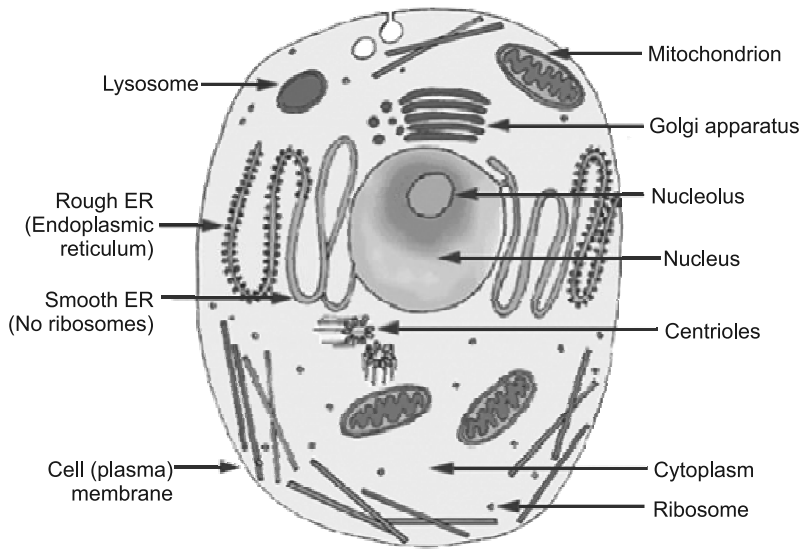
   These organisms are single-celled organisms that lack membrane-bound organelles.



2. **Eukaryotic cells:** These cells are evolved from prokaryotic cells over millions of years. They possess well defined (membrane bound) nucleus and other organelles. They are advanced and complete cells. Based on the number of cells, organisms are classified into unicellular and multicellular organisms.
Unicellular: They contain a single cell which performs all the functions, for example, *Amoeba*, *Paramecium* and *Chlamydomonas*.
Multicellular: In these organisms, many cells group together and perform different kinds of functions, for example, fungi, plants and animals.



Plant cell



Animal cell

3 STRUCTURAL ORGANISATION OF A CELL

A single cell is capable of performing various activities on account of different components as follows:

1. **Plasma membrane or cell membrane:** It is the outermost covering of the cell that separates the inside or contents of the cell from its environment. It is a living part of the cell. It is very thin and delicate.

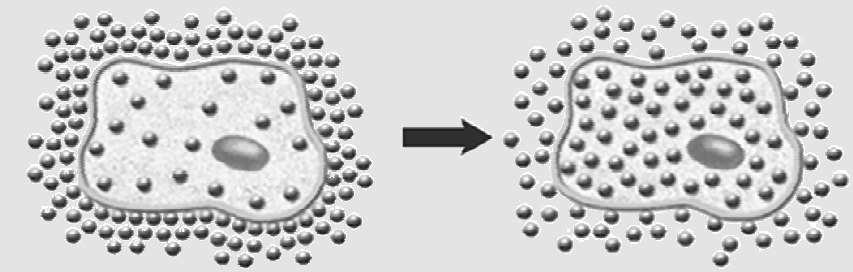
   Functions: It allows the entry and exit of selected material from the cell as it is selectively permeable membrane.

Transport of Substances Through Plasma Membrane

There are two processes through which material can pass through plasma membrane:

1. **Diffusion:** It is a process of movement of substances from the place of high concentration to a place of low concentration. Gaseous exchange occurs between cell and blood in our body by process of diffusion.

   If the oxygen level in a cell falls in comparison to the blood cell in our body, oxygen molecules enter into cell. Similarly, if carbon dioxide level in a cell increases in comparison to the blood cell in our body, the carbon dioxide molecules move out of cell.

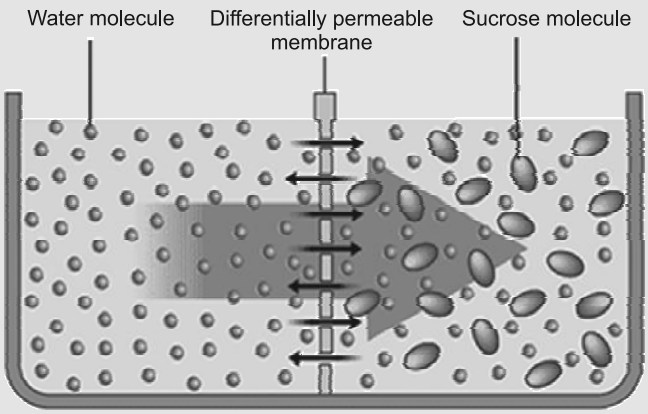


Before diffusion
There is a higher concentration of oxygen molecules outside the cell than inside the cell.

After diffusion
The concentration of oxygen molecules is the same outside and inside the cell.

2. **Osmosis:** It is a process of movement of water from a place of low solute concentration to a place of high solute concentration. Osmosis is opposite to diffusion because solvent such as water moves from low solute concentration to high solute concentration.

   In case the concentration of solute such as carbohydrates increases (as compared to its external environment) within a cell, then water enters from outside the cell. On the other hand, if the concentration of solute reduces within a cell, then the cell discharges water.

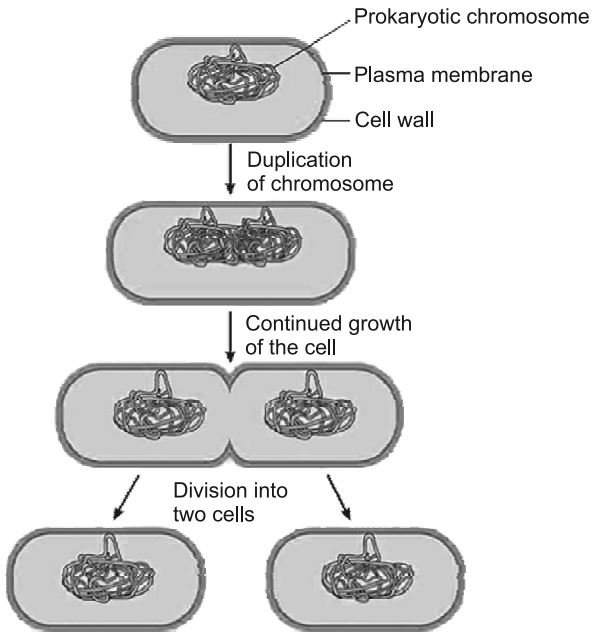


2. **Cell wall:** In addition to plasma membrane, the cell has another covering known as cell wall. The cell wall lies outside the plasma membrane and provides support to the cell's structure. It is present in eukaryotic as well as prokaryotic cells. Cell wall is a non-living part of the cell. It is thick, freely permeable and is made up of cellulose.

   Functions: It imparts rigidity and protection to the structure of cell. It is present only in plant cells and not in animal cells. It is because of cell wall, plants have hard outer covering. On the other hand, animals are soft to touch.

3. **Nucleus:** It is a dark coloured, spherical or oval dot-like structure which is present in the centre of each cell. Nucleus has a double-layered covering known as nuclear membrane. The nuclear membrane consists of pores which help in the transfer of materials from inside to the outside. Nucleus has a fluid present in it. The fluid which is inside the nucleus is called nucleoplasm.

   Nucleus consists of chromosomes which are rod-like structures. They carry genetic information in the form of DNA. DNA is present in the form of chromatin. Chromatin is an entangled mass of thread-like structure present within the nucleus. Chromatin leads to the formation of chromosomes.



In case of prokaryotic cells, because of lack of clearly defined nucleus, nucleic acids are present and are known as nucleoids.

Functions

- Nucleus determines the functioning of the cell and directs the activities of the cell organelle.
- It plays role in cellular reproduction.
- It is the storehouse of genetic information.

4. **Cytoplasm:** It is a clear jelly-like fluid that fills the inside of the cell and surrounds all the cell organelles. It helps in keeping the cell's internal components in place. It is thicker than water. In eukaryotes, cytoplasm specifically means the region outside the nucleus but inside the plasma membrane. On the other hand, the division between nucleus and other cell organelle is not clear in prokaryotic cells.

Functions

- Acts as a store for vital chemicals such as amino acids, proteins, sugar, etc.
- Site of metabolic activities of cell.
- Gives shape to the cell.

It further contains many constituents performing specialised functions called cell organelles. The various organelles present in the cytoplasm are as follows**:**

(i) Endoplasmic reticulum (ER): It is a large network of minute tubes (tubules). ER has structure similar to plasma membrane. ER is absent in prokaryotic cells.

ER is further divided into two types:

(a) Rough ER: Rough ER is rough (appears rough) on account of ribosomes attached to its surface. Ribosomes are a site of protein manufacture. These proteins are transferred by rough ER to various cell organelles.

(b) Smooth ER: Smooth ER helps in the manufacturing of some lipids and proteins which function as enzymes for digestion. These enzymes are used by lysosomes. Ribosomes are absent on Smooth ER. Smooth ER also plays other roles such as detoxification of liver cells from effects of many poisons and drugs.

Functions

- Rough ER helps in the synthesis and transport of proteins and smooth ER helps in the synthesis and transport of lipids.

(ii) Golgi apparatus: It consists of system of membrane-bound vesicles (bags) arranged parallel to each other in stacks. These stacks are called cisterns. With the help of Golgi apparatus, the material synthesised in ER is packaged and dispatched to various targets.

Functions

- It helps in storage, modification and packaging of products in vesicles.
- It facilitates the manufacture of complex sugars from simple sugars.
- It is involved in the formation of lysosomes.

(iii) Lysosomes: These are formed by Golgi bodies. These are waste disposal systems of a cell. It contains several digestive enzymes enclosed in a membrane. These enzymes can break down all organic material. In case the cell gets damaged and lysosomes burst, the enzymes present in it digest the whole cell. Therefore, these are also called suicidal bags of the cell.

Functions

- Keeps the cell clean by digesting foreign material as well as worn-out organelles.
- Provides protection against virus and bacteria.

(iv) Mitochondria: These are known as the powerhouse of the cell. They are small rod-shaped organelles. It has two membrane coverings. The outer layer is porous, whereas the inner layer

is deeply folded into numerous finger-like structures called cristae. They can make their own proteins as they have their own DNA and ribosomes.

Functions

- They release energy for activities of living cells.
- They store energy in the form of ATP (Adenosine triphosphate) which is the form of energy as required by a cell.

(v) **Plastids:** These are present only in plant cells and not in animal cells. They are usually spherical in shape. These are double membrane-bound organelles. Like mitochondria, they have their own DNA and ribosomes.

There are three types of plastids:

(a) **Chloroplasts:** Plastids containing green coloured pigment called chlorophyll are known as chloroplasts. They provide green colour to the leaves. These plastids play role in photosynthesis.

(b) **Chromoplasts:** Apart from chlorophyll, chromoplasts contain pigments of other colours such as yellow, orange, etc.

(c) **Leucoplasts**: Leucoplast is a primary organelle in plant cells for storage of certain materials such as starch, oils or proteins.

Functions

- Green plastids manufacture food through photosynthesis.
- Chromoplast gives colour to the flowers.
- Leucoplasts help in storage of protein, starch and oil.

(vi) **Vacuoles:** These are storage sacks for solid and liquid contents filled in the membrane. These are small sized in animal cells and large sized in plant cells. The vacuoles of some plant cells may occupy 50% to 90% of the cell volume. Due to its size, other organelles including nucleus shift towards plasma membrane.

Functions

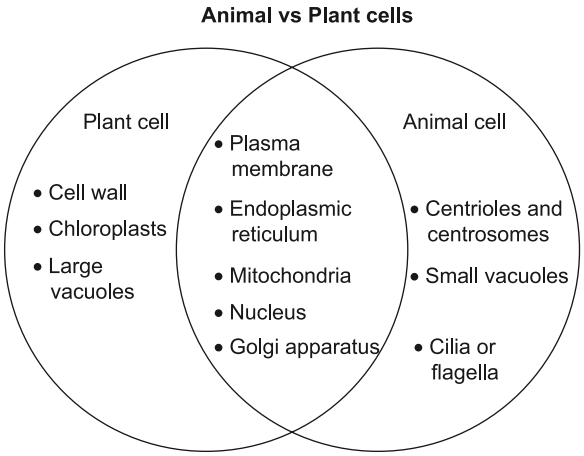
- Provides turgidity (swollen) and rigidity to the cell.
- Vacuoles carry substances important for cell such as amino acids, sugar, some proteins and other compounds.
- They can even store waste products so that the rest of the cell is protected from contamination.

(vii) **Centrioles:** Every animal cell has two small organelles called centrioles. These spindle fibres act as guides for the alignment of the chromosomes when they separate during the process of cell division. Though centrioles play a role in the reproduction within animal cells, plant cells are able to reproduce without them.

(viii) **Cilia or flagella:** Cilia and flagella have the same internal structure. The major difference is in their length. Cilia are short, and there are usually many (hundreds) cilia per cell. On the other hand, flagella are longer, and there are fewer flagella per cell (usually one to eight).

Functions: Cilia and flagella facilitate liquid movement along the surface of the cell. In humans, for example, cilia are found in the lining of the trachea (windpipe), where they sweep mucus and dirt out of the lungs.

In unicellular organisms such as protozoa, they help in locomotion.



4 TISSUE

We have learned that the living organisms are made up of cells. In unicellular organisms, single cell performs all the basic functions. On the other hand, multicellular organisms are made up of millions of cells. These cells, in a group, perform specific functions at a specific site in a body. A group of cells, similar in structure, that work together to perform a particular function form a tissue.

Comparison of Plant and Animal Tissues

There are major differences between plant and animal tissue. Plant and animal tissues are totally different.

Plants are stationary and therefore, most of the tissues in them are supportive and give structural strength. The tissues consist of dead cells and, hence, need less maintenance. Growth in the plants is limited to particular regions.

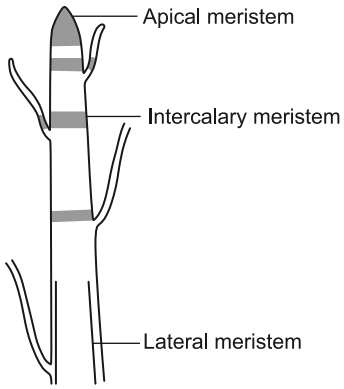
On the other hand, animals move around in search of food and shelter. The tissues consist of living cells and hence need more maintenance and energy. The growth pattern in animals is more uniform than in the plants. The structural composition of animals is very complex.

Plant Tissues

Some tissues in the plants keep on dividing throughout the year, whereas others do not divide at all. On the basis of their dividing capacity, plant tissues can be grouped into two types: growing or meristematic tissue and permanent tissue.

Meristematic Tissue

The dividing tissues, in the plant, are located at specific regions. Therefore, the growth of plants occurs only at these sites. Depending on the region where these tissues are present, meristematic tissues can be of three types: apical, lateral and intercalary.



Location of Meristematic Tissue in Plant Body

Apical meristematic tissue is present at the growing tip of stems and roots. It increases the length of stem and root. Lateral meristematic tissue increases the girth of stem or root. Intercalary meristematic tissue is present at the base of the leaves or internodes on the twigs (slender woody shoot growing from a branch or stem).

The cells of the meristematic tissue are very active, have dense cytoplasm, thin cellulose walls and prominent nuclei. They do not have vacuoles.

Permanent Tissue

Some cells lose the ability to divide and form a permanent tissue. The process of taking up a permanent shape, size and function is called differentiation.

The different types of permanent tissues formed are:

(i) **Simple permanent tissue:** This type of tissue consists of unspecialised cells with thin cell walls. They are live cells and are loosely packed with large intercellular spaces. This tissue supports the plant and acts as food storage.

Sometimes this tissue contains chlorophyll and performs photosynthesis and is thus called chlorenchyma.

Sometimes, it has large air cavities which make parts of plants to float in air and is called aerenchyma.

Collenchyma is another simple permanent tissue which gives flexibility and mechanical support to the plants.

The tissue which gives hardness and stiffness to the plant is called sclerenchyma. For example, husk of a coconut. This tissue acts as cement, hardens the covering of seeds and nuts and gives strength to the plant.

(ii) **Complex permanent tissue:** Complex tissues are those which are made up of more than one type of cells. These different types of cells coordinate to perform a common function, for example, xylem and phloem. Both are conducting tissues. Xylem and phloem are discussed later in detail.

Animal Tissues

Different types of tissues are present in our body to perform specific functions. On the basis of the function performed by them, they can be classified into four types:

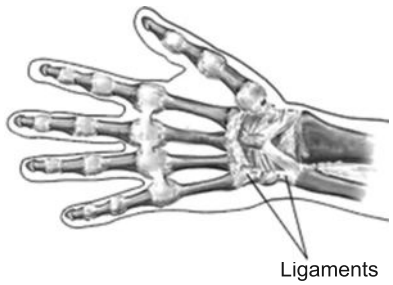
(i) **Epithelial tissue:** The covering or protective tissues in the animal body are epithelial tissues. It covers most of the organs and cavities and forms a barrier between different body systems. It is present in the skin, lining of the mouth, lining of blood vessels, lung alveoli, kidney tubules, etc. These cells are tightly packed, form a continuous sheet and have no intercellular spaces. The epithelial cells are permeable to some extent and, therefore, help in the exchange of materials between different parts of the body and the external environment.

(ii) **Connective tissue:** The cells of connective tissue are loosely spaced and embedded in an intercellular matrix. The matrix may be jelly like, fluid, dense or rigid. The nature of matrix depends on the function assigned to the particular connective tissue. Different types of connective tissue are as follows:

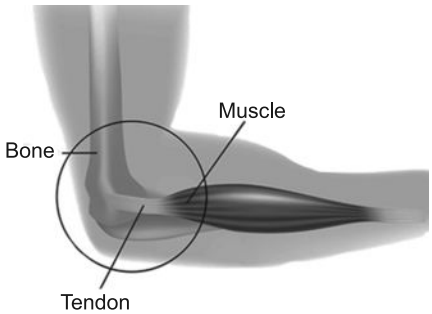
(a) **Blood**: Blood is a type of connective tissue. It has a fluid matrix in which red blood cells (RBCs), white blood cells (WBCs) and platelets are suspended. Blood transports oxygen, nutrients, hormones and other compounds to various parts of body, and it also helps in removing waste from our body cells.

(b) **Bone**: Bone is also a type of connective tissue. Bone cells are embedded in a hard matrix which is composed of calcium and phosphorus. This is a strong and non-flexible tissue. It forms a framework for supporting the body and anchors the muscles to support the important organs of the body.

(c) **Ligament**: Ligament is also a type of connective tissue. It connects the bones to each other. This tissue is highly elastic with considerable strength.



(d) **Tendons:** This is a fibrous tissue with great strength and less flexibility. It connects muscles to bones.



(e) **Cartilage:** It is firm, flexible connective tissue found in various forms in the larynx and respiratory tract, in structures such as the external ear, and in the articulating surfaces of joints. It is more widespread in the infant skeleton, being replaced by bone during growth.

(f) **Areolar connective tissue:** The areolar tissue located in the skin binds the outer layers of the skin to the muscles beneath. Areolar tissue is also found in or around blood vessels, nerves and the organs of the body.

(g) **Adipose tissue:** Its main role is to store energy in the form of fat, although it also cushions and insulates the body.

(iii) **Muscular tissue:** Muscular tissue consists of elongated cells called muscle fibres. This tissue helps in different movements of the body. Muscle fibres also contain special proteins called contractile proteins which contract and relax to cause movement. Different types of muscle fibres are as follows:

(a) **Striated muscles:** Striated or skeletal muscle fibres are long, cylindrical, unbranched and multinucleated. They show alternate light and dark bands when stained. They are also called voluntary (as they can be moved according to the will) muscles or skeletal (as they are attached to the bones and help in movement) muscles.

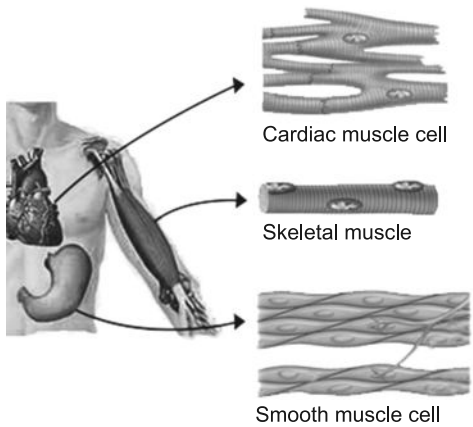
What Causes Fatigue in Our Body?

Our muscles produce lactic acid during intense exercise. It is a by-product of metabolism in our body. It causes muscle fatigue. Lactic acid deposits can be reduced by stretching of muscles.

We also feel fatigue when our muscles do not get enough energy.

(b) **Unstriated muscles:** Unstriated or smooth muscle fibres are long, with pointed ends and uninucleated. They are also called involuntary (as they work on their own without our will) muscles or smooth muscles. They are present in the alimentary canal, blood vessels, etc.

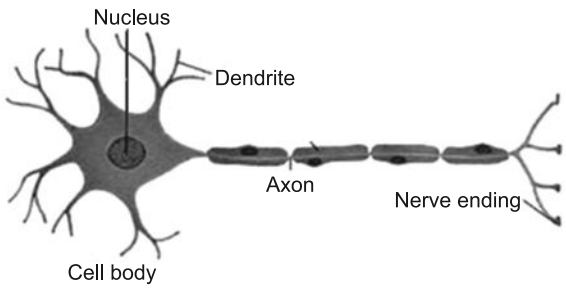
(c) **Cardiac muscles**: These are the involuntary muscles present in the heart. They show rhythmic contraction and relaxation throughout our life. These muscle fibres are cylindrical, branched and uninucleated.



(d) **Nervous tissue:** Nervous tissue is found in brain, spinal cord and nerves. It is made up of nerve cells or neurons. These neurons are highly specialised for being stimulated and

transmitting the stimulus from one body part to another. Each neuron consists of a cell body, a single long part called axon and many short branched parts called dendrites.

The combination of nerve tissue and muscle tissue enables human beings and animals to move rapidly in response to the stimuli.



Neuron: unit of nervous tissue

Practice Questions

1. Which one among the following cell organelles is semi-permeable?
   (a) Cell membrane
   (b) Vacuoles
   (c) Cell wall
   (d) Nucleus
2. Which one of the following cell organelles is absent in animal cell?
   (a) Cell membrane
   (b) Endoplasmic reticulum
   (c) Cell wall
   (d) Mitochondria
3. In the cells of living organisms, other than nucleus, which of the following organelles contains DNA?
   (a) Cell membrane
   (b) Endoplasmic reticulum
   (c) Golgi bodies
   (d) Mitochondria
4. Which of the following cell organelles play the most significant role in protein synthesis?
   (a) Lysosome and centrosome
   (b) Endoplasmic reticulum and ribosome
   (c) Golgi apparatus and mitochondria
   (d) Lysosome and mitochondria
5. The site of cellular respiration in animal cell is
   (a) Ribosome
   (b) Mitochondria
   (c) Endoplasmic reticulum
   (d) Lysosome
6. Which one of the following is the correct combination of subcellular structures in order if their relative size found in plant and animal cells?
   (a) Nucleus > Mitochondria > Chloroplast > Chromosomes

(b) Nucleus > Chromosomes > Mitochondria > Chloroplast
(c) Chloroplast > Nucleus > Chromosomes > Mitochondria
(d) Chloroplast > Nucleus > Mitochondria > Chromosomes

7. Consider the following statements:
1. Plant cells have fewer mitochondria than animal cells.
2. Plastids in a plant cell are the organelles enclosed by a single membrane.
3. The Golgi complex in a cell participates in the recycling of plasma membrane.

Which of the statements is/are correct?
(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

8. Match List 1 with List II and select the correct answer using the codes given below the lists:

(Cell Organelles)	(Physiological Phenomena)
A. Mitochondria	1. Photosynthesis
B. Chloroplast	2. Transpiration
C. Stomata	3. Respiration
D. Cell wall	4. Osmosis

(a) A-1, B-3, C-4, D-2
(b) A-3, B-1, C-4, D-2
(c) A-1, B-3, C-2, D-4
(d) A-3, B-1, C-2, D-4

9. Match List 1 with List II, and select the correct answer using the codes given below the Lists:

List I (Cell organelles)	List II (Functions)
A. Mitochondria	1. Sites for protein synthesis
B. Golgi complex	2. Synthesis of respiratory enzymes
C. Ribosomes	3. Site of photo-synthesis
D. Chloroplast	4. Secretion of hormones and enzymes

(a) A-4, B-2, C-3, D-1
(b) A-4, B-2, C-1, D-3
(c) A-2, B-4, C-3, D-1
(d) A-2, B-4, C-1, D-3

10. Consider the following statements: Our muscles ache after performing vigorous exercises because there is
1. A relative deficit of ATP in muscle tissue.
2. Total absence of ATP in muscle tissue.
3. Excessive accumulation of lactic acid in the tissues.
4. Ionic imbalance in the tissues.

Of these statements:
(a) 1, 3 and 4 are correct
(b) 2, 3 and 4 are correct
(c) 1 and 3 are correct
(d) 1, 2 and 4 are correct

ANSWER KEYS

Practice Questions

1. (a)	2. (c)	3. (d)	4. (b)	5. (b)
6. (a)	7. (b)	8. (d)	9. (d)	10. (c)

Unit – IV

ASTRONOMY

Solutions for

Practice Questions and Perfecting Past Prelims