36. Distance covered by boy A in time t

$$AC = vt \quad \ldots(i)$$

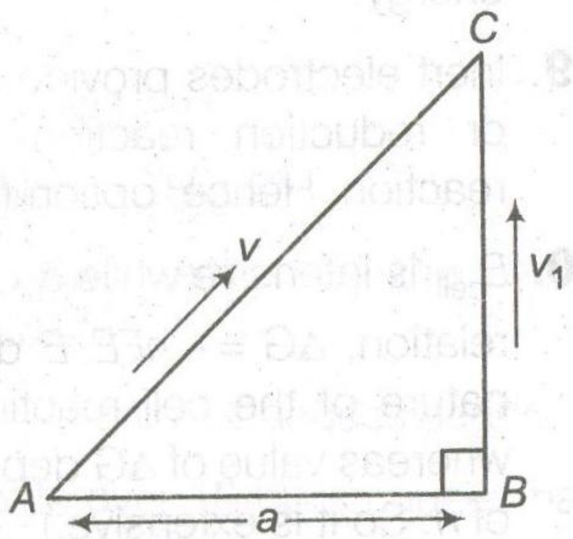
Distance covered by boy B in time t

$$BC = v_1 t \quad \ldots(ii)$$

Using Pythagourus theorem

$$AC^2 = AB^2 + BC^2$$

or $$(vt)^2 = a^2 + (v_1 t)^2$$



or $$v^2t^2 - v_1^2t^2 = a^2$$

or $$t^2(v^2 - v_1^2) = a^2 \therefore t = \sqrt{\frac{a^2}{(v^2 - v_1^2)}}$$

37. Power $P = i^2R$

$$\Rightarrow \quad R = \frac{P}{i^2}$$

given, $P = 1\,W$, and $i = 5\,A$

$$\therefore \quad R = \frac{1}{(5)^2} = 0.04\,\Omega$$

38. Force $F = at + bt^2$

From principle of homogeneity,

Dimension of $at = \frac{[F]}{[t]} = \frac{[MLT^{-2}]}{[T]}$

$$= [MLT^{-3}]$$

Similarly, dimensions of

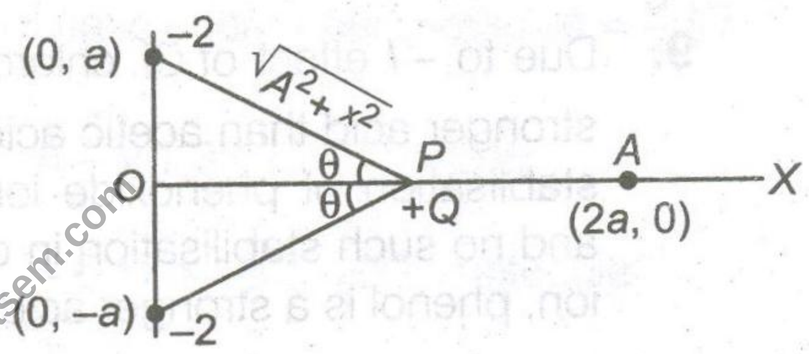
$$b = \frac{[F]}{[t^2]} = \frac{[MLT^{-2}]}{[T^2]}\,[MLT^{-4}]$$

39. Component of force on charge of $+Q$ at P, along x-axis,

$$F_x = \frac{2Qq}{4\pi\varepsilon_0(a^2 + x^2)} \times \frac{x}{\sqrt{a^2 + x^2}}$$

$$= \frac{2Qqx}{4\pi\varepsilon_0(a^2 + x^2)} \times \frac{x}{\sqrt{a^2 + x^2}}$$

$$= \frac{2Qqx}{4\pi\varepsilon_0(a^2 + x^2)^{3/2}}$$



Which is not directly proportional to x.

So, motion is oscillatory but not SHM.

40. The percentage of volume of ice cube outside the water is

$$= \frac{\rho_{water} - \rho_{ice}}{\rho_{water}} \times 100$$

$$= \frac{1000 - 900}{1000} \times 100 = 10\%$$

Chemistry

1. *n*-alkanes, in presence of anhy. $AlCl_3/HCl$ undergo isomerisation to form branched chain alkanes.

2. Only one water molecule, which is outside the brackets (coordination sphere) is hydrogen bonded. The other four molecules of water are coordinated.

3. Among the oxoanions if chlorine given in the question, ClO_4^- does not disproportionate because in this oxoanion chlorine is present in its highest oxidation state *i.e.*, + 7.

4. $(CH_3)_3N$ have unshared pair of electrons which can be donated and shared with an electrophile.

5. 1 M of 10 mL H_2SO_4 = 1 M of 20 mL NH_3

1000 mL of 1 M ammonia contains

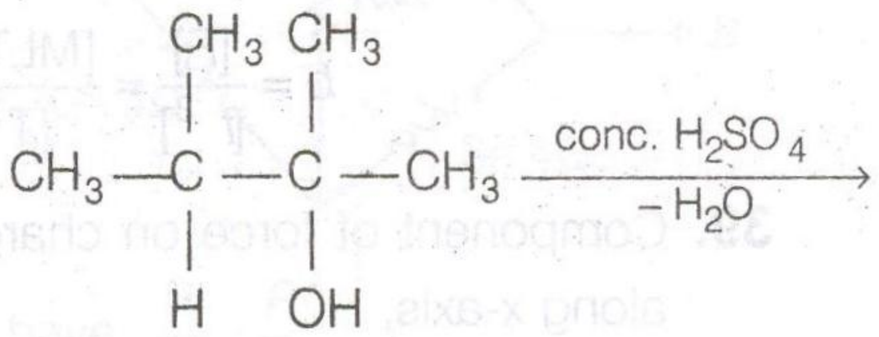
= 14 g nitrogen

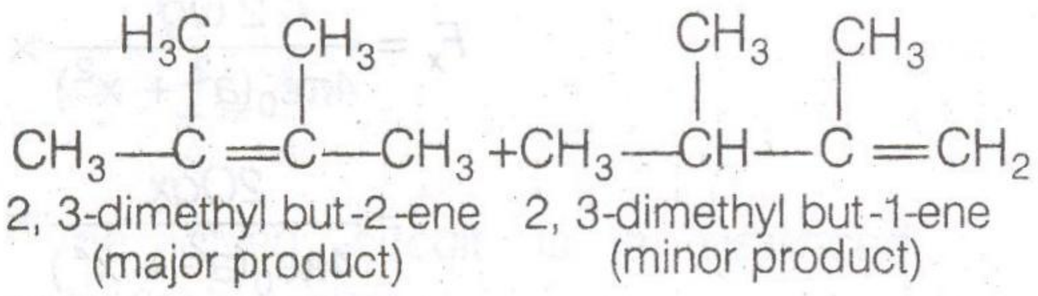
20 mL of 1M NH_3 contains

$$= \frac{14 \times 20}{1000}\text{ g nitrogen}$$

$$\%\text{ age of nitrogen} = \frac{14 \times 20 \times 100}{1000 \times 0.5} = 56.0\%$$

6. Compound (II) is most symmetrical because it has both CH_3 groups and Cl atoms *p*-to each other. Therefore, it fits in the crystal lattice better than the other two isomers and hence it has highest melting point.

7.




8. $CH_3CH_2C{\equiv}CH \xrightarrow{H^+/H_2O,\ Hg^{2+}} CH_3CH_2COCH_3$

9. Due to $-I$ effect of Cl, chloroacetic acid is a stronger acid than acetic acid. Further dur to stablisation of phenoxide ion by resonance and no such stabilisation in case of ethoxide ion, phenol is a stronger acid than ethanol.

Hence, overall acid strength increases in the order; ethanol < phenol < acetic acid < chloroacetic acid.

10. In fcc structure, there are $4F^-$ ions in the packing and hence 4 octahedral voids.

11. $\pi = CRT$ or $C = \dfrac{\pi}{RT}$

$= 8.21\ \text{atm}/0.0821\ \text{L atm K}^{-1}\ \text{mol}^{-1} \times 310\text{K}$

$= 0.323\,\text{M} = 0.323 \times 180\ \text{gL}^{-1}$

$= 58.14\,\text{gL}^{-1}$

12. At equilibrium, rate of dissolution = rate of crystallisation.

13. Thiosulphato (SCN) is ambidentate/unidentats ligand.

14. $2\,KMnO_4 + 2\,H_2SO_4\ (\text{conc.}) \longrightarrow Mn_2O_7 + 2\,KHSO_4 + H_2O$

15. $3d^5$ has maximum unpaired electrons ($5e^-$), so it has magnetic moment.

16. Phosphorus belongs to 3rd period and henc contains *d*-orbitals which can form $p\pi$-d bonds.

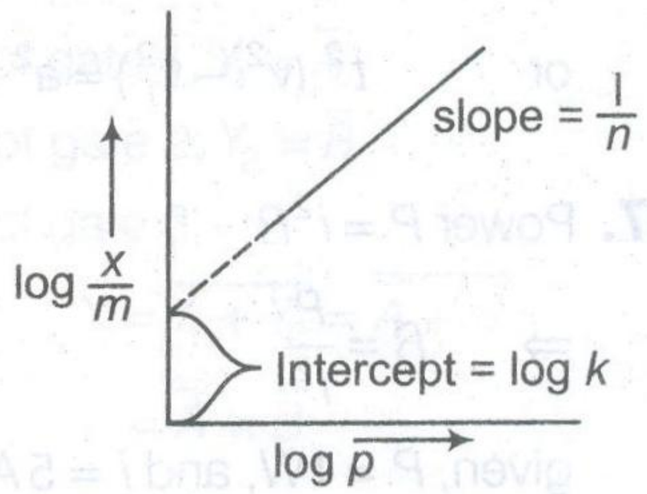
17. HI being a stronger reducing agent tha H_2SO_4, reduces H_2SO_4 to SO_2 and is itse oxidised to I_2.

18. F being smallest has the shortest HF bond an hence HF has the highest bond dissociatio energy.

19. Inert electrodes provide surface for oxidatio or reduction reaction but not for redo reaction. Hence, option (d) is incorrect.

20. E_{cell} is intensive while $\Delta_r G$ is extensive. (In th relation, $\Delta G = -nFE$, E depends only on th nature of the cell reaction so it is intensiv whereas value of ΔG depends upon the valu of n. So it is extensive.)

21. Option (c) is correct



According to Freundlich adsorption isotherm a graph between $\log \dfrac{x}{m}$ against $\log p$ is a straight lline with slope equal to $1/n$ and intercept equal to $\log k$.

22. Aluminium is the third most abundant elemen by mass and iron is the second mos abundant metal in the earth's crust.

23. Nitrogen in, N_2O, NO, N_2O_3, NO_2 or N_2O_4 and N_2O_5 nitrogen shows + 1, + 2, + 3, + 4 and + oxidation states respectively.

24. $PH_3 < AsH_3 < NH_3$ (enthalpy of vaporisation)

25. A halogen of lower atomic number oxidises halide ions of higher atomic number.

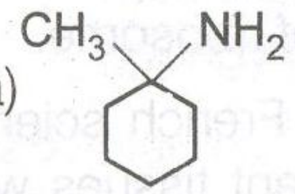
$Br_2 + 2\,NaI \longrightarrow 2NaBr + I_2$

26. A catalyst does not alter the enthalpy change ΔH of the reaction.

27. Rate $= k[A][B]$; when volume is reduced to $\frac{1}{4}$th, concentration will become 4 times:

Therefore, new rate $= k[4A][4B] = 16\,k[A][B]$

$= 16$ times

28. (a) 

(b) $(C_2H_5)_3N$; 3°

(c) $(CH_3)_3C-NH_2$; 1°

(d) $C_6H_5-NH-CH_3$; 2°

29. Sodium rosinate enhance the lathering porperty of soap.

30. Deficiency of vitamin 'C' causes scurvy.

31. Excess fluoride over 10 ppm causes harmful effects to bones and teeth.

32. Adiabatic process is a process in which there is no transfer of heat between the system and surroundings, ($q = 0$).

33. $\Delta_r G° = 2.303 \log Kp\ (R = 8.314\ JK^{-1}\ mol^{-1})$

$\Delta_r G° = -2.303 \times 8.314\ JK^{-1}\ mol^{-1} \times 298K \times \log 2.47 \times 10^{-29}$

$= 163000\ Jmol^{-1} = 163\ kJmol^{-1}$

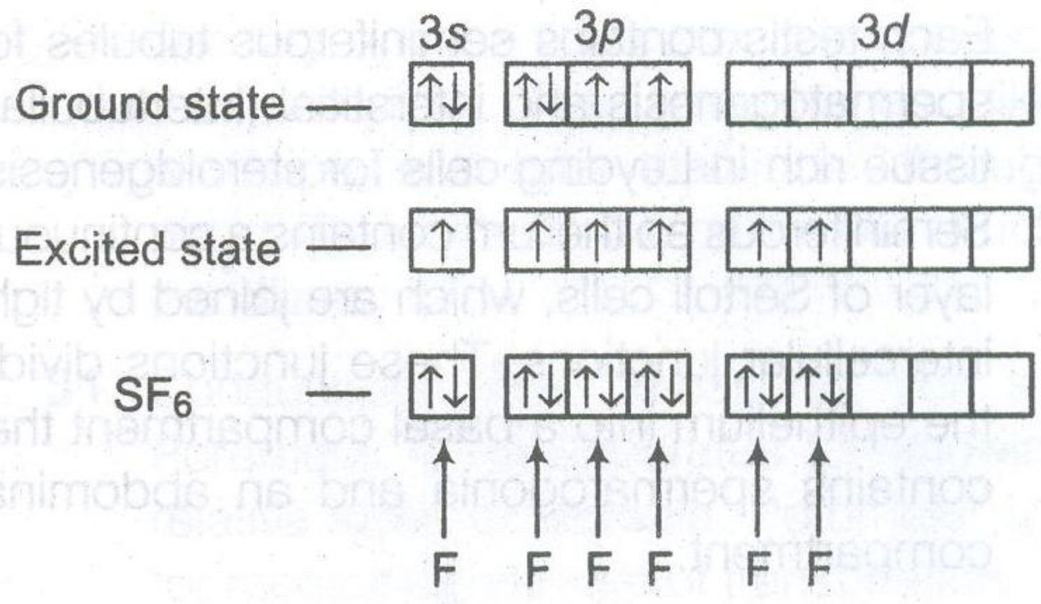
34. Option (d) is wrong statement.

$C_2\ (12e^-) = \sigma 1s^2\ \overset{*}{\sigma} 1s^2, \sigma 2s^2, \overset{*}{\sigma} 2s^2$

$(\pi 2px_2 = \pi 2py_2)$

In C_2 molecule, double bond consists of both π bonds.

35. S(16 e^-) ground state $= 1s^2, 2s^2, 2p^6, 3s^2, 3p^4$



sp^3d^2 hybridisation

36. Covalent character increases with decrease in the value of difference in electronegativites of binding atoms. Thus, the correct order is

$LiCl < BeCl_2 < BCl_2 < CCl_4$

37. Maximum number of electrons in a subshell of atom is determined by $4l + 2$.

38. Average kinetic energy per molecule $= \frac{3}{2} KT$

$= \frac{3}{2} \times 1.38 \times 10^{-23} \times 298$

$= 6.17 \times 10^{-21}\ JK^{-1}\ molecule^{-1}$

39. $pH = 7 + \frac{1}{2}[p^{K_a} - p^{K_b}]$

$= 7 + \frac{1}{2}[4.76 - 4.75]$

$= 7 + \frac{1}{2} \times 0.01 = 7 + 0.005$

$= 7.005$

40. Reaction quotient, $Q_c = [B][C]/[A]^2$

as $[A] = [B] = [C] = 3 \times 10^{-4}M$

$Q_c = (3 \times 10^{-4}) \times (3 \times 10^{-4})/(3 \times 10^{-4})^2 = 1$

As $Q_c > K_c$, so the reaction will proceed in the reverse direction.

Zoology

1. Pellagra is caused by deficiency of vitamin-B_5. Therefore, vitamin-B_5 is also known as antipellagra factor. Symptoms of this disease are thick pigmented skin of head, swollen lips and patient feels irritable.

2. Notochord originates from mesoderm germ layer.

3. Parthenogenesis is a form of sexual reproduction in which the ovum develops into a new individual without fertilisation.

4. Bartholin's gland is found in vagina. Bartholin glands are a pair of small glands, which occur on each side of the vaginal opening. These glands correspond to cowper's gland of male.

5. Each testis contains seminiferous tubules for spermatogenesis and interstitial (Intertubullar) tissue rich in Leyding cells for steroidgenesis. Seminiferous epithelium contains a continuous layer of Sertoli cells, which are joined by tight intercellular junctions. These junctions divide the epithelium into a basal compartment that contains spermatogonia and an abdominal compartment.

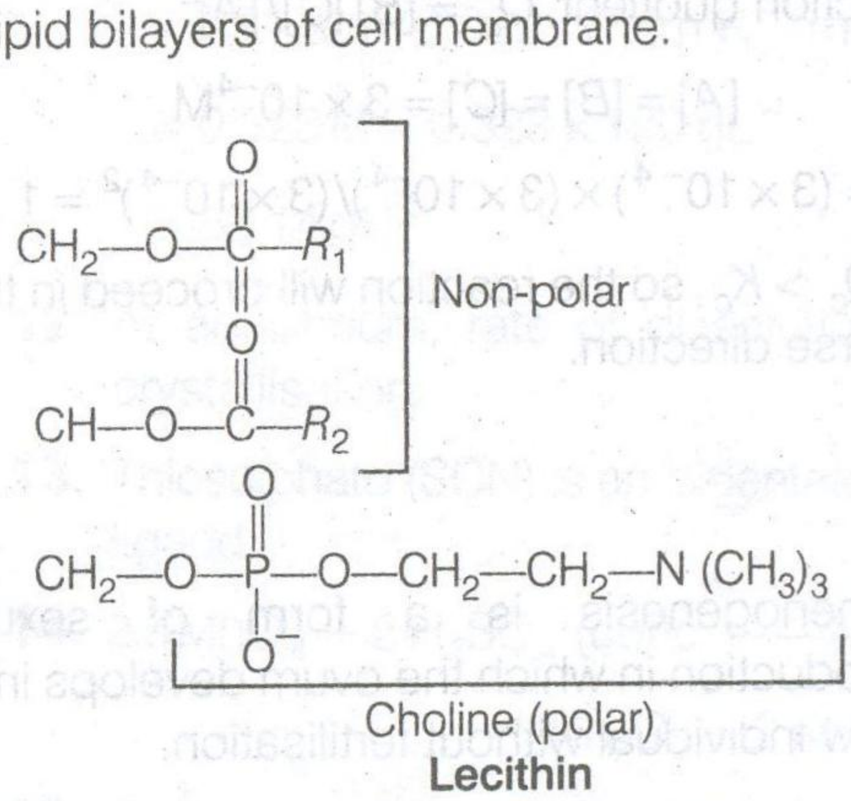
6. Teratogens is an agent that can cause malformations of an embryo on foetus. This can be a chemical substance, a virus or ionising radiation. Mostly, during first three months of pregnancy the pregnant lady should avoid all contact with teratogen.

7. A mature ovarian follicle is called Graafian follicle. After ovulation, the empty Graafian follicle shows deposition of luetin and forms corpus luteum that ultimately degenerates.

8. Basic amino acids have an additional amino group without forming amides thus, they are diaminomonocarboxylic acids. *e.g.*, lysine arginine, etc.

9. In cell cycle there are two main phases-interphase and mitotic phase. Interphase is divided into three stage G_1, S and G_2. G_1 is first growth phase. S is synthetic phase and G_2 is second growth phase.

10. 'A' is a structural formula of lecithin. It is probably the most common phospholipid. Phospholipids are major components in the lipid bilayers of cell membrane.



Lecithin

11. Mesosomes will be equivalent to mitochondria of eukaryotes because of respiratory enzymes present in aerobic bacteria.

12. Centrosome is a self-propagating cytoplasmic organelle, located near nucleus of animal cell.

13. The plasmalemma series as the interface between the machinery in the interior of the cell and the Extracellular Fluid (ECF) that bathes all cells. It is devoid of ribosome.

14. In 1824, Pene Dutrochet, a French scientist wrote that all animal and plant tissues were aggregate of globular cells.

15. Scientific name of gharial or gavial is *Gavialis gangeticus*, which lives in rivers Ganga and Brahamputra.

16. Cephalochordate have notochord all along the body through out life. But urochordates have notochord in the tail region in their larval stage only.

17. In molluscs, the blood is colourless, often having copper containing blue respiratory pigment called haemocyanin.

18. Chlorogogen cells are excretory in function. The chlorogogen cells take up excretory matter from the blood capillaries of the gut and from the coelomic fluid of the coelom. They also store glycogen and fat. So, these cells are analogous to the liver of vertebrates.

19.

Cyclostomes	—	Agantha
Aves	—	Tetrapod
Tunicates	—	Urochordata
Balanoglossus	—	Hemichordata
Osteichthyes	—	Pisces

20. Chondrichthyes (cartilaginous fishes) are marine. Their mouth is ventral and they have cartilaginous endoskeleton. Dermal placoid scales are present, e.g., Scoliodon, Pristis, etc.

21. Study of amphibians and reptiles is called Herpetology. Study of aves is called Ornithology. Study of fishes is called Ichthyology.

22. Ligaments join a bone with another bone in movable/synovial joints. Torn ligaments make movement at joints very painful and restricted. It heals only after prolonged movement restriction.

23. Achondroplasia is a defect in the formation of cartilage at the epiphyses of long bones producing a form of dwarfism.

24. Bone marrow is of two types; red and yellow. The yellow marrow is found especially in medullary cavity of long bones, while red is in spongy bones.

25.

Neuron	—	Nissl's bodies
Bone-matrix	—	Ossein
RBCs of man	—	Non-nucleated
Lymphocytes	—	Antibodies

26. Diastema is the gap that separates the biing teeth from the grinding teeth in herbivores. It creates a space in which food can be held ready for the grinding action of the teeth.

This space is filled by large canine teeth in carnivores.

27. Pepsin is released from peptic cells of the gastric gland on the stomach wall and it can digest milk protein caesin.

Chymotrypsin is released from the intestine and digest proteins. Ptyalin is released from salivary glands and acts on starch.

28. Goitre is a swelling of the neck due to enlargement of the thyroid gland. This may be due to lack of dietary iodine, which occurs due to decreases thyroid function, which is necessary for the production of thyroxine hormone.

This was the cause of endemic goitre, formerly common in regions, where the people lacked in their diet iodine.

29. Prolactin or luteotrophic hormone or luteotrophin is a hormone, synthesised and stored in the anterior pituitary gland, that stimulates milk production after child birth and also stimulates production of progesterone by the corpus luteum in the ovary.

30. At its bottom, the trachea (another name for the wind pipe) branches into two tubes called bronchi, which lead into the lungs.

The larynx is the voice box. It is connected to the windpipe. The oesophagus, like the windpipe, is a tube that runs through the neck. The lungs are the ballon like structure in the chest.

31. Conductivity meter measures soil salinity. Porometer is an apparatus for knowing the relative sizes of stomata. Potometer is used for measuring the rate of transpiration.

32. Both predation and parasitism show negative interactions. In negative interaction one species is harmed (–) while the other is benefitted.

33. Sunlight is the ultimate source of energy as it is the only inexhaustible resource, which is utilised by green plants and is passed on to higher tropic levels through food chain.

34. Endemic species represents a population that are restricted geographically to a particular area in a given time.

35. Species diversity on earth is not uniformly distributed but shows interesting patterns. It is generally highest in the tropics and decreases towards the poles.

36. The effect of cigarette smoking and radon in combination on lungs is synergistic.

37. '*Taq*' and '*Pfu*' are thermostable enzymes, which are isolated from thermophilic bacteria. They are DNA polymerase in nature, which are widely used in polymerase chain reaction.

38. Biolistics is a technique far introducing genetic material into living cells, especially plant cells in which DNA- coated microscopic particles are fired into the cell using a special gun.

39. The largest known gene in human is the dystrophin gene, which has 79 axons spanning at least 2300 kb. The human dystrophin gene requires 16 hours to be transcribed.

40. Herbicide resistant gene in plants is *Bt* gene *Bacillus thuringiensis* is the bacterium that occur naturally in soil. It is now used as herbicide or biopesticide.

Botany

1. Photosynthesis is an oxidation reduction process in which water is oxidised and carbon dioxide is reduced to carbohydrates. Hence, it is anabolic and endergonic process.

2. Zeatin is a cytokinin. IAA or indole acetic acid is a natural auxin. IBA or indole butyric acid and NAA or nepthalene acetic acid are synthetic auxin.

3. Cytokinin is a plant growth hormone, which is mostly synthesised in the roots, cytokinin delays leaf senescence.

4. C_4-plants have an alternative CO_2 fixation pathway called Hatch and Slack cycle. These plants have Kranz anatomy in leaf, where vascular bundles are surrounded by bundle sheath.

In C_4 cycle light reaction occurs in, mesophyll chloroplast by PEP carboxylaes and the assimilation of CO_2 takes place in, *i.e.*, dark phase in bundle sheath chloroplast by Rubisco.

5. Scotoactive mechanism of opening of stomata is seen in fleshy xerophytes like *Opuntia*, cactus, etc. They keep their stomata open at night and closed during daytimes.

6. Genetic dwarfism is overcome by the usage of gibberellins. Ethylene is a gaseous hormone, which induces ripening in unripe fruits. ABA cause ageing and abscission of leaves.

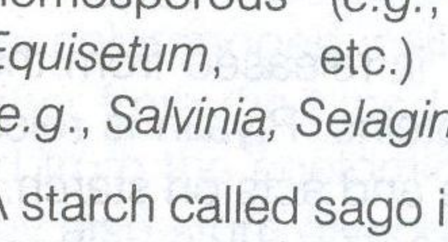
7. Ethylene is a natural gaseous hormone, which is predominantly known for inducing fruit ripening.

8. In the year 1900 Hugo de Vries, Karl Correns and Erich Tschermark independently rediscovered the research carried out by Mendel, his experiments on heredity and variations and laid the basic of modern genetics.

9. The 1st generation obtained from crossing two parents is called as first filial generation or F_1-generation.

10. Skin colour in humans is controlled by three pair of genes Aa, Bb, Cc.

11. Axillary position (A) is dominant over terminal (a) position. When Aa × Aa is crossed we get 3 :1 ratio. of axillary and terminal flowers.



	A	a
A	AA	Aa
a	Aa	aa

3 Axillary : 1 Terminal

12. Seed producing plants belong to spermatophyta. It includes gymnosperms and angiosperms. Seed orginated in gymnosperms. Fern and *Funaria* belong to pteridophytes and bryophytes respectively. So, they do not reproduce by producing seeds.

13. The sporophyte of pteridophyte produces meiospores inside sporangia, which may be homosporous (*e.g.*, *Adiantum, Dryopteris*, *Equisetum*, etc.) or heterosporous (*e.g.*, *Salvinia, Selaginella,* etc.)

14. A starch called sago is obtained from the pith of *Cycas revoluta*. That is why it is called sago palm.

15.

Column I	Column II
A. *Cuscuta*	4. Parasite
B. *Eichhornia*	5. Root pocket
C. *Monotropa*	1. Saprophyte
D. *Rhizophora*	2. Pneumatophore
E. *Utricularia*	3. Insectivorous plant

16. Lipopolysaccharide present on cell wall of bacteria acts as endotoxin.

17. Endosperm of gymnosperm is a pre-fertilisation tissue. It is basically the female gametophyte hence it is haploid unlike triploid in angiosperm.

18. Pteridophyte are called vascular cryptogams. They are seedless vascular plant as they possess water conducting xylem and food translocating phloem but do not produce seed (instead spare formation takes place).

19. Bacillariophyceae contains unicellular golden brown autotrophic protists (diatoms). As the name diatoms indicates the body is covered with bivalved Silicaceous shell or frustule having an upper half or epitheca and a lower half or hypotheca.

20. Guard cell are the specialised epidermis cells containing chloroplast.

21. Epidermal extensions are always unicellular, while epidermal appendages may be uni or multicellular. Root hairs are epidermal extensions formed by outward elongated bulging of wall of epidermal cells.

22. Lady finger (*Abelmoschus esculents*) belongs to family—Malvacae. This family is distinguished by presence of epicalyx, staminal tube, extrose anthers, monothecous, and syncarpous ovary.

23. Interxylary phloem is found in *Calotropis* stem. It is said to be interxylary due to its presence inside xylem. It is also found in same member of family– Solanceae.

24. Secondary meristem are the meristem that are formed secondarly from the permanent tissue. Healing of wound in plant take place by the activity of secondary meristem.

25. Angular collenchyma occurs in *Cucurbita*. It has thickening at the angles and there are no intercellular spaces. It is generally found in leaf petioles.

26. In angiosperm, companion cells are living cells along with sieve tube and phloem parenchyma of the phloem. In pteridophytes and gymno sperm phloem is without companion cell.

27.

Common Name	Scientific Name	Family	Order	Class
Wheat	*Triticum aestivum*	Poaceae	Poales	Monocotyledons
Mango	*Mangifera indica*	Anacardiaceae	Sapindales	Dicotyledons
Housefly	*Musca domestica*	Muscidal	Diptera	Insecta
Man	*Homo sapiens*	Hominidal	Primata	Mammalia

28. Agar-agar is obtained from members of Rhodophyceae algae collectively called agarophytes. These include *Gelidium*, *Gracillaria*, etc.

Agar is a jelly, like substance used for culturing processes. It is used as laxatives in bacteriological and mycological media.

29. DNA molecule has four bases-adenine guanine cytosine and thymine. Adenine always pairs with thymine and guanine pairs with cytosine. Their association is A-T and G-C.

30. According to Chargaff's rules, the amount of adenine is always equal to that of thymine, and the amount of guanine is always equal to that of cytosine.

$$A = T(120)$$

$$G = C(120)$$

The total number of nucleotides would be $120 \times 4 = 480$.

31. Lactose is popularly known as milk sugar. It is a disaccharide composed of one molecule of glucose and one molecule of galactose.

It is a reducing sugar.

32. Meiosis is best observed in dividing microsporocytes. Microsporocytes or microspore mother cell after meiosis give rise to microspore.

Other cell do not divide by meiosis.

33. In a majority of water plants like water hyacinth and flowers, water lily emerge above the water level and are pollinated by insects.

34. Pollinia is a coherent mass of pollen grains. They are the product of only one anther lobe, but are transferred during pollination as a single unit.

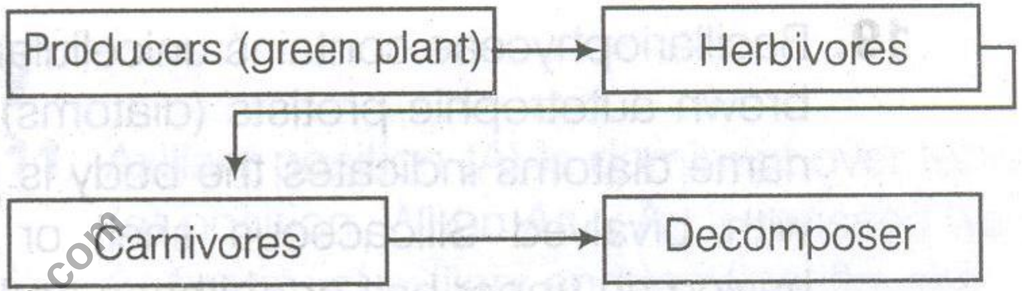
This is found in orchids (Orchidaceae).

35. Morphine is the principle opium alkaloid. It is a strong analgesic. Opium is dried latex of unripe capsular fruits of poppy plant, *Papaver somniferum*. It is eaten or smoked.

36. Pebrine is a disease of silkworm caused by a small parasite. *Nosema*, which has a devastating effect on silk industry.

37. Topographical conditions greatly influence the soil profile (earth surface) within a given climatic region.

38. In an ecosystem, the direction of flow of energy is always in this pattern.



39. If the Bengal Tiger becomes extinct its gene pool will be lost forever. Gene pool is the collective name for all the genes of a particular population.

40. Water hyacinth (phytoplankton), can purify water polluted by biological and chemical wastes-water hyacinth has remarkable capacity to accumulate poisonous metals including radioactive substances.