Q. No. 2 Part (i) **ROLE OF BACTERIA IN NITROGEN CYCLE:** Bacteria play an important role during nitrification, nitrogen-fixation and denitrification steps.

- **NITRIFICATION:** During nitrification, bacteria convert ammonia and ammonium ions into nitrates. First group i.e, Nitrosomonas convert ammonia and NH_4^+ into nitrites whereas a second group i.e, Nitrobacter convert nitrites to nitrates which are then used by plants.
- **NITROGEN FIXATION:** During this step, Free nitrogen in atmosphere is converted to ammonia by nitrogen fixing bacteria which is then made available to plant during lysis of free-living nitrogen fixing bacteria azotobacter (aerobic), clostridium (anaerobic) or by symbiotic association. (Rhizobium). $N_2 + 3H_2 \longrightarrow 2NH_3$
- **DENITRIFICATION:** During this step, Nitrates are converted back to gaseous nitrogen by denitrifying bacteria e.g: Pseudomonas in order to fill their oxygen requirement. $NO_3 \rightarrow NO_2 \rightarrow N_2O + NO \rightarrow N_2 + O_2$

Q. No. 2 Part (ii) **IDENTIFICATION AND FUNCTION:**

A: Kidney **B**: Ureter **C** = Urinary Bladder.

A-KIDNEY: It performs excretory and osmoregulatory function. Being an excretory organ it filters blood to remove toxins, excess water and salt and remove them from body as urine. Its osmoregulatory function include: forming diluted urine during state of flood and concentrated urine during dehydration to keep body fluids in normal concentration.

B-URETER: Ureter transports urine from kidney to urinary bladder.

C-URINARY BLADDER: It acts as urine reservoir. It is hollow, distensible, muscular organ that temporarily stores urine until it is carried by urethra to body's exterior.

Q. No. 2 Part (iii) **TRANSFORMATION OF R- to S-TYPE:**

Dead S-strain bacteria is non-virulent but when it is mixed with living non-virulent R-strain bacteria the genes encoding virulence and polysaccharide capsule are transferred from dead S-type bacteria to Living R-type bacteria resulting in the **transformation** of living R-type non-virulent bacteria to living S-type virulent bacteria having surface protein configuration of previously living R-strain.

RESULT: As a result of this transformation, the mice died, as they were injected with living S-type bacteria which is highly **virulent** and formed by mixing of living R-type and dead S-type bacteria. **DNA** was the active factor responsible for this transformation.

Q. No. 2 Part (iv) **GENE MUTATION:**

Gene mutation is permanent change in the sequence of DNA nucleotide. It is caused by the change of a single nucleotide or few nucleotide in DNA which occurs by gene insertion, deletion or substitution. **SYPTOMS OF SICKLE CELL ANAMIA:** Painful episodes lasting from hours to days, as the anaemia gets severe patient suffers from, fever, fatigue, paleness, jaundice, shortness of breath e.t.c.

CAUSES =It is an Autosomal recessive diseases. One can get a disease if inherited from both parents. It occur due to defect in haemoglobin. Actually six amino acid i.e, Glutamic acid in β-chain of haemoglobin is replaced by valine. Gene code for glutamic acid (CTT) is replaced by (CAT) which encodes valine. As a result, abnormal haemoglobin is produced (Hb^S) causing RBCs to develop sickle shape with decrease oxygen-binding capacity.

Q. No. 2 Part (v) **SEWAGE TREATMENT:**

It is a process of removing wastes and contaminants from sewage. It requires three treatment processes.

PRIMARY TREATMENT: It includes holding water temporarily in quiescent basin. It removes suspended and floating wastes as sludge. The remaining liquid is discharged or subjected to secondary treatment.

SECONDARY TREATMENT: It removes suspended and dissolved biological matter. It uses indigenous water-born microorganism in controlled habitat. It further requires separation of microorganism prior to discharge or tertiary treatment.

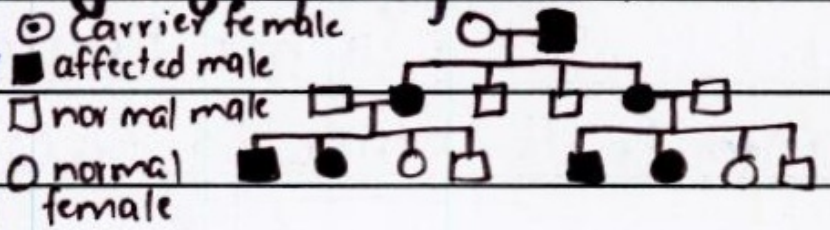
TERTIARY TREATMENT: In tertiary treatment, the treated liquid is further treated physically or chemically (Chlorine gas) prior to discharge in rivers, lakes, streams.

Q. No. 2 Part (vi)

NUCLEOSOME	PRIMOSOME
• A complex of DNA molecule wrapped around core of eight histones form nucleosome.	DNA helicase and primase enzyme are found in the form of complex in DNA called primosome.
• Formed during DNA organization	• Function during DNA replication.
HETROCHROMATIN	**EUCHROMATIN:**
• A highly condensed and unexpressed region of chromatin present only in eukaryotes is called hetrocheromatin.	• An uncondensed and expressed region of chromatin present in both prokaryotes and eukaryotes is called euchromatin.
SENSE CODON	**NON-SENSE CODON**
A codon encoding amino acid is called sense codon. e.g: AUG (Methionine).	• A codon does not encoding amino acids is called non sense codon. These are stop codon in mRNA UGA, UAG, UAA

Q. No. 2 Part (vii) **DIFFERENT INHERITANCE PATTERN:**

• In X-linked recessive, female carrying one X-linked recessive mutation is carrier and will not show symptoms of diseases. Males having one X-linked recessive mutations are diseased. All offsprings of carrier female have 50% chance of inheriting mutation. These mutations zigzag from maternal grandfather to carrier doughter to affected grandson. They never pass directly from father to son. e-g: haemophilia	In X-linked dominant, female carrying one X-linked dominant is affected, and so is male. All offsprings of affected mother have 50% chance of inheriting mutation. All daughters of affected father are affected no son of affected father is affected, as sons dont receive father's X-chromosomes. e-g: Hypophosphatemic rickets.



Q. No. 2 Part (viii) **ANIMAL HUSBANDRY:**

Animal husbandry deals with taking care of livestock such as cows, buffaloes, sheep, goat, poultry horse e.t.c. It includes, feeding them, watering them, keeping their living space clean, helping them deliver (calving), medicating sick animals, herding branding e.t.c. It is agriculture practice of raising livestock.

ROLE IN NATIONAL ECONOMY:

Livestock provides, egg, meat, dung for fuel, wool, milk e.t.c. Wool and leather products of animals are exported to earn foreign exchange. Live stock contributes to 11% GDP and 17% Work force including most poorest people in the country. Livestock contribution to national economy is estimated in millions. This sector can single-handedly become a game changer for national economy.

Q. No. 2 Part (ix) **ROLE OF MICROBS IN INDUSTRIAL PRODUCTION:**

Microbes play various roles in industrial processes.

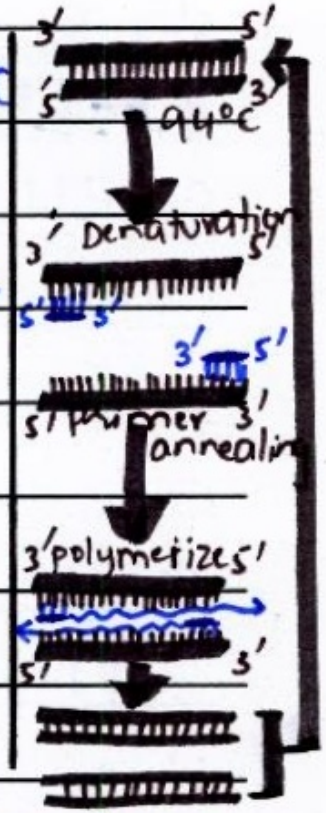
(i) The give higher specifity and higher yield than conventional processes.

(ii) A wide range of chemicals can be used and produced.

(iii) Microbes plays useful role in production of complex chemicals like antibiotics, vaccine and complex amino acids like (L- amino acid) can be produced.

Q. No. 2 Part (x) **PCR:**

Target DNA, primers, free nucleotides (dNTP) and Taq Polymerase (Temperature insensitive) are dissolved in suitable buffer and then placed in PCR machine. DNA is amplified by following three steps:



- **DENATURATION:** In this step, target DNA is heated to 94°C for 1 min. This denaturizes double stranded DNA to single stranded DNA. These ssDNA then act as templates.
- **PRIMARY ANNEALING:** In this step, two primers, forward and backward primer anneal to ssDNA at complementary region. It takes place at 54°C for 2 min.
- **POLYMERIZATION:** In this step Taq polymerase synthesizes daughter strands from 3' end of primer by adding dNTPs. It takes place at 72°C for 1 min. It produces Two daughter DNA molecules each of which repeat the cycle.

Q. No. 2 Part (xi) **CLEANING OF INHALED AIR:**

- Nose hair, cilia and mucous serve as defence mechanism against microorganisms and particulate matter present in air.
- Cilia and mucous remove haimful pathogens from air as well as particulate matter present in the air before it reaches lungs.
- Mucous helps in moistening air.
- Cilia removes the trapped particle to pharynx for their removal.

Therefore by the action of cilia, mucous and nose hair air is cleaned before it reaches lungs.

Q. No. 2 Part (xii) **HAEMATOMA FORMATION:**

As the bone breaks, blood vessels in bones and surrounding area torn and haemorrhage. Haematoma or clot forms at fracture site. Soon, bone tissue deprived of nutrition die and tissue at site becomes swollen, inflamed, painful.

CALLUS FORMATION:

Capillaries grow in haematoma and phagocytic cells invade to clean debris. A fracture penetrates periosteum and results in the release of numerous osteoblasts which combine with cartilage forming cells to form a porus mass of bone and cartilage called callus. It replaces haematoma in 3-4 weeks. Within a month, it is replaced by hard bony callus of spongy bone which forms throughout repair (2 months). Osteoclasts breat cartilage and osteoblast tranforms it into bone.

Q. No. 2 Part (xiii) **PROCESS OF ELECTROPHORESIS:**

This technique is used to separate fragments of charge bearing polymers under influence of electric field in semi-solid gel medium (agarose, polyacrylamide). The fragments to be saparated are dispensed in a well in gel medium. Gel is placed in electrophoresis chamber and is connected to power source. Under influence of electric field, molecules begin to opposite pole movement, in gel.

PRINCIPLE: The movement of molecules depend on size, because a distance DNA fragment travels is inversely proportional to length. Movement also depends on shape of molecule, charge, Number of strands and gel pore size i.e, its concentration. As a result different size fragments will be separated which can then be visualed by UV or X-rays. Thus, smaller molecules move faster as compared to larger.

Q. No. 2 Part (xiv) **PLANT BREEDING:**

- **ACCLIMITIZATION:** Introduction of plant to new locality from their original environment and their adjustment is referred as acclimatization. e.g: plants like papaya from west-indies were introduced in subcontinent by this method.
- **SELECTION:** Selection involves selecting better plants from the entire yield. These better plants are then separated from inferior ones and reproduced favourably under controlled condition.
- **HYBRIDIZATION:** It is the process of introducing desirable characteristics of two different plants in a single offspring. Hybrids are known for their vigour yield, strength and pest resistance. They propage vegitatively and retain characteristics e.g: hybrid varieties of cereal grains, mule (donkey and horse).

Q. No. 3 (Page 1) **LABELLING:**

1- Arriving action potential at synaptic knob.
2- Neurotransmitter vesicle containing neurotransmitter
3- Synaptic cleft.

NAME OF PROCESS

SYNAPTIC TRANSMISSION

DETAILED PROCESS

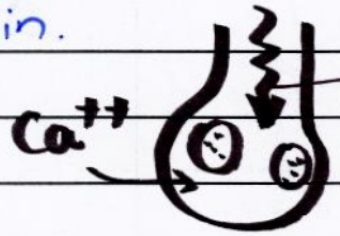
SYNAPTIC TRANSMISSION:

Transmission of nerve impulse across synapse is called synaptic transmission. It takes place in the formation of message in the form of chemical called neurotransmitter.

Axons have synaptic knob at their distal ends. These contain synaptic vesicle containing neurotransmitter and when impulse arrives at knob, these vesicles release neurotransmitter.

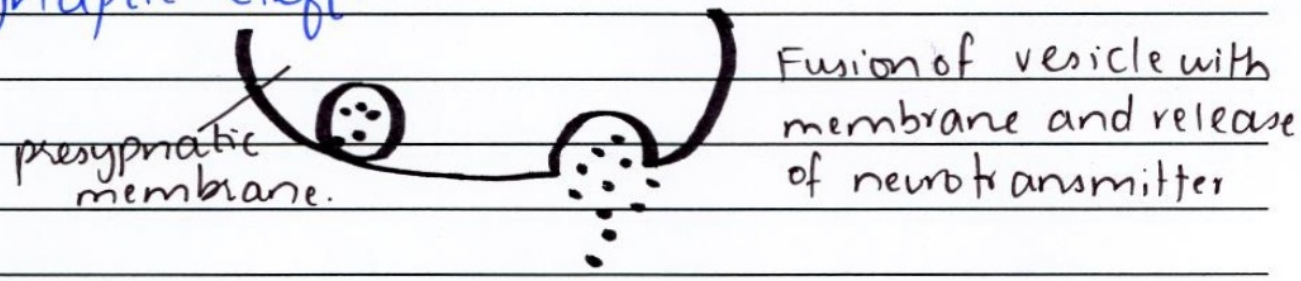
MECHANISM:

- As the nerve impulse arrives at presynaptic membrane, Ca^{++} gates in membrane open. As concentration of Ca^{++} is lower in bulb than outside. Therefore calcium rushes in.

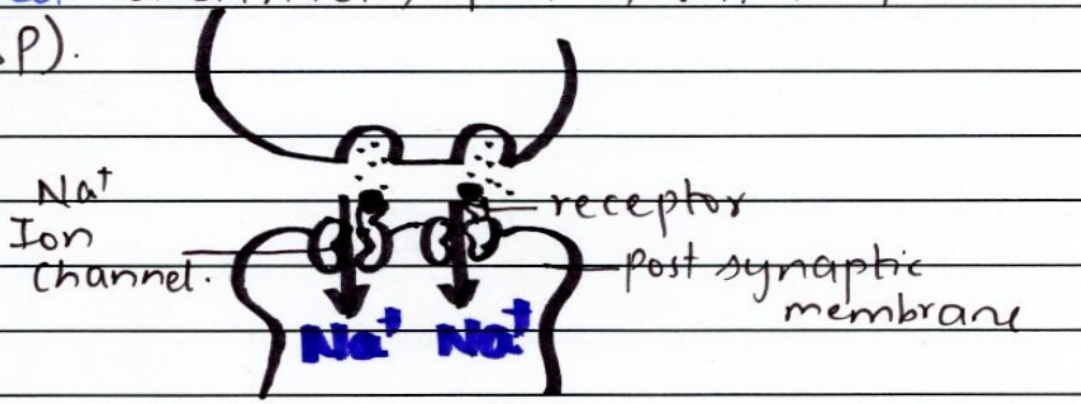


- The increasing Ca^{++} concentration forces neurotransmitter vesicles to move towards

presynaptic membrane and fuse with it. After fusion, these vesicles release neurotransmitter in synaptic cleft which diffuses across synaptic cleft.



- Neurotransmitter binds with receptors in postsynaptic membrane. This binding open Na^+ channel in postsynaptic membrane. Therefore Na^+ rushes inside and depolarizes and generates action potential in postsynaptic membrane. Since this depolarization bring membrane potential to threshold level. Therefore it is called EXCITATORY POST SYNAPTIC POTENTIAL (EPSP).



- After neurotransmitter has acted on receptor in postsynaptic membrane, it is broken down by enzymes like acetylcholine is hydrolyzed by acetylcholinesterase and adrenalin by monoamine oxidase.

Q. No. 3 (Page 3)

Q. No. 4 (Page 1)

DNA RECOMBINANT TECHNOLOGY:

- GENE OF INTEREST:

A gene which is to be cloned is called gene of interest. It is obtained in three ways.

(i) Artificial gene synthesis is used to synthesize gene in vitro with template DNA using DNA synthesizer machine.

(ii) Gene of interest can be prepared from its mRNA, using enzyme reverse transcriptase which are naturally found in retroviruses. Gene synthesized in this way is called complementary DNA.

(iii) Gene of interest can be cleared from chromosomal DNA using restriction endonuclease.

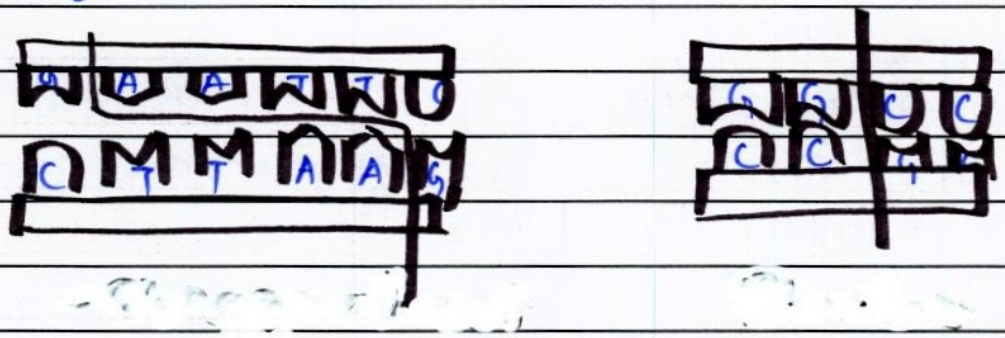
- MOLECULAR SCISSOR:

Restriction endonucleases are used to cleave both strands of DNA at specific sequences called restriction site or recognition site. These sites contain palindromic sequence contain 6 to 8 bases in symmetrically reverse order.

First restriction endonuclease was isolated in 1970. These are naturally found in bacteria and serve in host defence by cleaving DNA of attacking viruses.

These make either sticky end or blunt cuts.

Staggered cut are those where resulting dupkr fragments have single stranded projected ends called sticky ends.
Whereas as blunt cuts don't have them end.



Blunt cut Staggered cut

-MOLECULAR GLUE:

This enzyme is responsible for forming phosphodiester bond between adjacent nucleotide and joins DNA Fragments.
In rDNA experiment DNA ligase is used to anneal gene of interest and vector DNA by their stickly ends.

- MOLECULAR CARRIER:

Vector carries foreign gene in host organism for its multiplication. A small circular DNA molecule of bacterial origin called plasmid is used as carrier.

Q. No. 4 (Page 3) In order to act as vector DNA has following characteristics.

- Origin of replication site.
- Restriction sites of enzymes
- Antibiotic resistant gene

e.g: plasmid, Yeast Artificial chromosomes, etc.

• EXPRESSION SYSTEM:

An organism acting as host for recombinant vector to express is called expression system. Therefore it is selected on basis of vector used in making recombinant DNA. In order to act as expression system, following characteristics are important:

(1) Simple genetics
(2) Short generation time.

Both these characteristics are present in bacterial cells. Therefore bacterial cells result as ideal expression system.

Q. No. 5 (Page 1)

MULTIPLE ALLELES:

If genes having more than two alleles, then such alleles are called multiple alleles. Multiples alleles are produced by gene mutation. There can be as many as 100 multiple genes but each individual has only twice of them as each gene is represented twice in a diploid individual.

e.g: If A_1, A_2 and A_3 are three alleles then individual has only two for trait

A_1A_1, A_1A_2, A_1A_3, A_2A_3, A_2A_2, A_3A_3

REASONS OF DIFFERENT PHENOTYPES:

As there are more than two alleles for a trait each having its own phenotypic effect. But in diploid individuals only two of them are present as each locus is represented twice in individual. Due to various possible combinations different phenotypes are produced.

ABO BLOOD GROUP:

ANTIGENS:

These are markers present on RBC membrane. ABO blood group system has 2 antigen.
Antigen A results in A blood groups
Antigen B results in B blood groups
Both A, B antigens result in type AB.

whereas no antigen result in type O blood group.

GENETIC BASIS:

ABO blood group system is controlled by single polymorphic gene I (Isohaemoglutinogens).

Four types of blood groups result by combination of 3 alleles.

I^A for A antigen
I^B for B antigen
i for no antigen.

Dominance relationship is very interesting. I^A and I^B are completely dominant over i and I^A and I^B are co-dominant to each other, express themselves in hetrozygous states.
Thus,

$I^A I^A$, $I^A i$ Type A blood group

$I^B I^B$, $I^B i$ Type B blood group

$I^A I^B$ Type AB blood group.

$i\ i$ Type O blood group.

As the combinations of these three alleles I^A, I^B and i in various ways result in four phenotypes thus it is an example of multiple alleles.

CONCLUSION:

Thus, due to various combination of alleles, different phenotypes can be produced from multiple alleles such as that described in ABO blood group system.

CONTROL OF BREATHING:

Normally we cannot control our breathing as it is an involuntary action. A breathing center located in MEDULLA of brain carries out the involuntary control of breathing.

Its ventral portion increase the rate and depth of inspiration and is called inspiratory center.

Its dorsal and lateral portions inhibit inspiration and stimulate expiration and is called expiratory center.

VOLUNTARY CONTROL: Through the cerebral cortex, it is possible to increase or decrease the rate and depth of breathing voluntrally or involuntarily. People can voluntarily hold their breath. Occassionaly people can hold their buath until O_2 partial pressure falls to such as low level that a person lose consciousness. Once consciousness is lost, respiratory centre again start involuntary control of breathing.

Emotions acting through LIMBIC system can also affect breathing.

MECHANISM OF BREATHING:

Lungs themselves can neither draw in air nor push it out. Diaphragm and intercostal muscles are responsible for contraction and

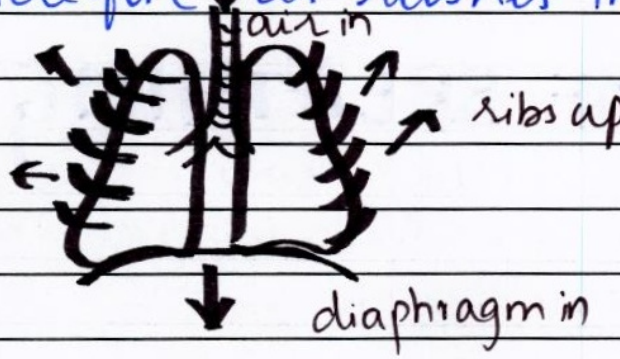
expansion of lungs.
Diaphragm is a dome-shaped skeletal muscles that separates thoracic and abdominal cavity.
There are two sets of intercostal muscles between two ribs. External intercostal and internal intercostal. Mus fibres are arranged diagonally but in opposite direction in two sets of muscles.

PHASES OF BREATHING:

Breathing takes place in two phases:

• INSPIRATION:

- It is the taking in of air, to take O_2
- It is the active phase of breathing
- During inspiration, diaphragm contracts and become less dome shape
- External intercostal contract and internal relax.
- This cause rib cage to move upward and forward.
- This increases area of thorax and decreases pressure on lungs less than atmosphere.
- Therefore air rushes in.



EXPIRATION:

- It is the giving out of air, to expel CO_2.
- It is the passive phase of breathing.
- During expiration, diaphragm relaxes and retains its dome shape.
- Contraction of internal intercostal and relaxation of external intercostal.
- Rib cage moves backward and downward.
- This decreases area of thorax and increase pressure on lungs.
- Lungs therefore contract and air is expelled out.