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Q. No. 2 Part (i) **Extraembryonic Membranes:**

These are the membranes formed outside the embryo during embryonic development during **first trimester.**

⇒ Extraembryonic membranes are four in number.

- **Amnion:** It is the innermost membrane that provides a fluid environment to developing embryo and foetus.
- **Allantois:** This extraembryonic membrane contributes to the circulatory system.
- **Chorion:** It is the outermost extraembryonic membrane that forms villi that burrow into endometrium and it mingles with endometrium to form placenta.

Q. No. 2 Part (ii) **Role of Telomeres:**

- **Telomeres:** Telomeres are the specific sequence of nucleotides located at the end of chromosomes. When humans are conceived, telomeres have full length.
- **Role in aging:** When humans are conceived, telomeres have full length however as cells continue to divide, telomeres reduce in size. ~~with~~ Thus with every cellular division slight reduction in telomere size occurs. Finally at old age, telomeres reduce to such critical length that cell gets unable to divide. This gives rise to many problems, as organs stop functioning properly. It causes signs and symptoms of aging and eventually the health deteriorates and death occurs.

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Q. No. 2 Part (iii) **Role of Neural Crest:**

- **Neural crest:** The neural crest is formed at the neural plate border. When the neural tube pinches off, these neural crest cells migrate to lateral sides of neural tube and give rise to a number of structures.
- **Structures formed from neural crest:**

Sensory nerves are developed from neural crest. Once they reach lateral sides of neural tube, ~~and~~ they give rise to cranial, spinal and sympathetic ganglia and associated nerves. Subsequently, the neural crest cells migrate to the rest of embryo and form medulla of adrenal gland, teeth, parts of skull and sensory nerves. So many other structures are derived from neural crest that some people call it "fourth germ layer."

Q. No. 2 Part (iv) **Allometric growth:**

- **Definition:** The differential growth rates of the different body parts resulting in a change in size and proportion of body is called "allometric growth."
- **Example:** (i) When a baby is born, the head is larger as compared to rest of body. Brain and head develope rapidly during initial years and head reaches 90% of total size by six years of age.

(ii) Afterwards the growth of arms and legs occur more rapidly during childhood so that a person reaches to normal body proportions.

(iii) Growth of reproductive systems occurs in puberty.

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Q. No. 2 Part (ix) **Primary function of respiratory system:** The most primary function of human respiratory system is **exchange of gases.**

- **Intake of O_2 and releasing out CO_2:**
- The oxygen is required for cellular respiration in aerobic organisms. This oxygen is obtained from external environment, ~~from~~ through respiratory system.
- The carbon dioxide (CO_2) produced as a by-product of respiration is released out through this system. Hence it is **helpful to body.**

The exchange of gases occurs through **alveoli** of lungs with the **blood** present in the capillaries surrounding it. Thus respiratory system functions to allow exchange of gases through the respiratory surface (alveoli).

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Q. No. 2 Part (v) **Role of restriction enzymes:**

- **Restriction endonucleases:** These are the enzymes that are responsible for the cleavage of the phosphodiester bonds of DNA duplex in order to separate a DNA fragment from rest of DNA molecule.
- **Role of restriction enzymes:** These restriction enzymes are responsible of **cleaving the gene of interest** from the total chromosome of a cell. Thus the restriction enzymes cleave the phosphodiester bond, separating the gene of interest from the chromosome. These restriction endonucleases are called **molecular scissors**. They forms two types of cuts:

(i) staggered cut: That has single stranded projected ends.
(ii) Blund cut: That does not have single stranded projected ends.

Restriction enzymes also cleave vector DNA from its total chromosome.

Q. No. 2 Part (vi) **Major steps in DNA sequencing:**

In all the DNA sequencing techniques, following are the three major steps involved:-

(i) Production of different sized DNA fragments that all start at the same point but end at different points.
(ii) Separation of these different sized DNA fragments occurs through the process of electrophoresis.
(iii) Reading of the sequence of the nucleotides of DNA by the electrophoresed gel.

Q. No. 2 Part (vii) **• Purpose of vector:** The vector molecule acts as a carrier molecule in order to carry the gene of interest into the host cell. The common characteristics that a vector must posses: (i) origin of replication site (ii) restriction sites for different enzymes. (iii) Antibiotic resistant gene.
Commonly used vectors are small circular DNA of bacterial origin (Plasmid).

• Purpose of DNA ligase enzyme: DNA ligase enzyme is responsible for the formation of phosphodiester bonds between two nucleotides in order to ~~form~~ join two DNA fragments.
In DNA cloning, the DNA ligase enzyme joins gene of interest and vector DNA. (It anneals them from their sticky ends).

Q. No. 2 Part (viii) **Structure of uterus:**

- Uterus or "womb" is a hollow, muscular organ.
- It has three parts: Fundus, Body, Cervix.
- It is somewhat shaped like an inverted pear. The oviducts join the uterus just below fundus.

• Layers of uterine wall: The uterine wall has 3 layers:

(i) **Perimetrium:** Thin, outermost covering layer of uterus.

(ii) **Myometrium:** Middle, thick layer which is composed of bundles of smooth muscles that is responsible for producing rhythmical contractions during childbirth.

(iii) **Endometrium:** Inner most spongy lining of the uterine cavity (in which embryo is implanted).

• Cervix: Cervix is a narrow opening that leads from the uterus to the vaginal canal. (Usually it is blocked by mucus.)

Q. No. 2 Part (x) **Evidence of evolution: molecular biology:**

The study of molecular biology supports evolution:-

(i) All the living organisms use same basic biomolecules that are **DNA, ATP and identical enzymes.**

(ii) Living organisms use same DNA code and same twenty amino acid for **protein synthesis.**

(iii) **Cytochrome C** is a molecule present in the electron transport chain of all organisms.

(iv) Some organisms have same types of **introns.**

All of these evidences from molecular biology support the **common descent hypothesis of evolution.**

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Q. No. 2 Part (xi) **Conditions of Hardy-Weinberg theorem:**

Following are conditions required to meet the Hardy-Weinberg theorem:

(i) Population should be large.

(ii) There must be no gene flow.

(iii) There must be no mutations.

(iv) There must be no selection.

(v) Reproduction must be random.

Q. No. 2 Part (xii) **Role of hypothalamus:**
(in endocrine system).

Hypothalamus ach as the **master control centre** of endocrine system. (It controls the secretions of pituitary gland).

- **Role of neuro-secretory cells:** Hypothalamus is largely composed of neuro-secretory cells. These cells can **conduct** nerve impulse and have also developed **secretory activity** to a high level. These cells secrete **regulatory hormones** which influence the secretions of **pituitary gland**. These regulatory factors are either: release factor: stimulate anterior pituitary secretions. inhibitory factor: inhibit anterior pituitary secretion. These hormones are packaged into granules and passed down the axons by **cytoplasmic streaming**, and are passed into the blood capillaries.

(Section B)

Q. No. 2 Part (xiii) **Climax community:**

- Climax community is the final community that is formed at the endstage of ecological succession.
- During ecological succession, the communities successively replace each other and at the end of this succession, **a climax community is formed.**

Significance: The climax community is relatively stable community formed at the end of ecological succession and it is better able to cope up with the environmental conditions. These are not further replaced by any community.

Example: Mesophytic trees formed at the end of **xerarch succession** is a climax community.

Q. No. 2 Part (xiv) **Role of Diaphragm:**

The contraction and relaxation of diaphragm is responsible for carrying out the process of respiration (inhalation and exhalation).

- **Inhalation:** Diaphragm contracts, and is lowered. It increases volume of chest cavity. Air rushes in from outside environment.
- **Exhalation:** Diaphragm relaxes and is raised, reducing the volume of chest cavity. Pressure increases thus air releases out of lungs into environment.

Q. No. 3 (Page 1)

Transport of CO_2:

A total of three mechanisms are involved in transport of CO_2 from tissues into the blood.

(i) In the form of carboxy haemoglobin:

About 7% of total CO_2 is transported in the form of carboxyhaemoglobin.

XX - XY Mechanism of sex determination:

- In humans, the pattern of sex determination is XX- XY. There are a total of 46 chromosomes (23 pairs). Out of which 22 pairs of homologous chromosomes are called **autosomes**.
- One pair of chromosomes that is different in males and females is called **sex-chromosome**.

Males: In humans males are XY. They contain one X-chromosome and one Y-chromosome. Males form sperms. Haf of the sperms carry X-chromosome and remaining half carries Y-chromosome. Since males produce different gametes, thus they are called **heterogametic**.

Females: Female humans are XX. They carry two X-chromosomes. Females produces one type of egg cell, all of them carrying X-chromosomes only. Thus females are called **homogametic**.

Q. No. 3 (Page 2)

Sex of the offspring:

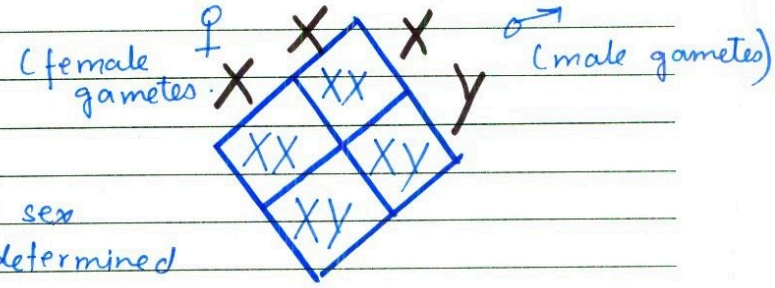
- If a sperm carrying X-chromosome fertilizes an egg, then the offspring will be **female**. having genotype **(XX)**.
- If a sperm carrying Y-chromosome fertilizes an egg. then the offspring will be **male** with genotype **(XY)**

- **Sex ratio:** The sex ratio of male and female offspring in humans is **1:1**.

Males are called heterogametic:

Males are **XY** and they produce sperms. These sperms are of two types. Half of sperms carry X-chromosome and remaining half carries a Y-chromosome.

⇒ The type of sperms produced by males are two thus they are called **heterogametic**.



In humans, the sex of offspring is determined by male sperms.

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Q. No. 3 (Page 3)

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Q. No. 4 (Page 1) **PCR: Polymerase Chain Reaction.**

PCR is a method of gene cloning that occurs in an **invitro medium.** In this process, the DNA polymerase enzyme is compelled to synthesize and clone a given piece of DNA again and again, thereby forming hundreds of thousands of copies of a given gene or DNA fragment.

Taq polymerase enzyme: During PCR, a special type of DNA polymerase is used called "taq polymerase" enzyme. It is a special **temperature resistant** enzyme that remains active and stable at high temperatures. It is obtained from **thermus aquaticus**, a bacteria living in hot water springs.

Reaction mixture: The PCR reaction mixture consists of (i) Taq polymerase enzyme, (ii) Free nucleotides (iii) Primers (iv) template DNA dissolved in a suitable buffer. The reaction mixture is then put into **thermocycler** or **PCR machine**. That maintains temperature, duration and sequence of each step.

Mechanism of PCR:

(i) Denaturation: The first step is the denaturation of template DNA. This process is done by **heating** the template DNA at a temperature of **92°C** for a duration of **1 minute**.

Q. No. 4 (Page 2) As a result of denaturation, the double stranded DNA molecule is converted into two single strands. Each single strand acts as a **template DNA** for the synthesis of new DNA in next steps.

(ii) Primer Annealing:

In this step, the forward and backward primers are annealed with **3' end** of each template strand. This step requires ~~vari~~ relatively lower temperature. The exact value is dependent on size and sequence of primer however, the average temperature used for this purpose is **54°C** for about **2 minutes.**

(iii) Polymerization:

In this step, the taq polymerase enzyme synthesizes new strand along the template strand by adding nucleotides to the 3'end of primers. This step requires a temperature of **72°C** and time of **1 minute.**

As a result one target DNA molecule is converted into two molecules.

Immediately after this, a second phase of PCR starts followed by denaturation, primer annealing and polymerization.

Applications: The PCR technique has a wide range of applications:

(i) It is used to produce multiple copies of the

Q. No. 4 (Page 3) given gene or DNA and thus converts it into thousands of copies. The number of DNA molecules being produced at the end of each cycle doubles. Thus PCR is used for **gene cloning**. By producing multiple copies of a ~~of~~ given gene.

(ii) PCR technique is used in **DNA sequencing** technique in order to produce different sized DNA fragments during sanger coulsen method of DNA sequencing.

(iii) During **DNA analysis**, if the DNA to be analysed is in very small amount, then it is amplified by using PCR technique.

Q. No. 5 (Page 1)

Action potential:

Action potential: Active membrane potential or action potential refers to the depolarized state of neuron which **conducts nerve impulse.** This is maintained by the presence of more negative charge outside the neuron membrane and more positive charge inside. This is known as active membrane potential **or action potential.**

Labelling of graph:

X : **Depolarization**
Y: **Repolarization**
Z: **Hyperpolarization.**

X: Depolarization:

When a neuron fibre is stimulated by a nerve impulse then it causes the opening of **voltage regulated Na^+ gates.** When these gates open, the Na^+ ions diffuse **along concentration gradient** from outside the cell to inside. Since Na^+ ions are **positively charged** thus the outside of membrane gets **negative** and inside gets **positive.**
Therefore the membrane potential changes from **-70mV** to zero and then increases to **50mV.** This is known as **depolarized state.**

Q. No. 5 (Page 2)

Y: Repolarization: In repolarization, the resting membrane potential is re-achieved by following two processes:-

- **Opening of voltage regulated K^+ gates:** A fraction of second after the opening of sodium gates, the de-polarized axon fibre stimulates the opening of **voltage regulated K^+ gates.** Thus K^+ ions move along their diffusion gradient and diffuse out of the membrane of neuron. Since K^+ ions are **positively charged**, thus they move to bring back the resting membrane potential. This marks the beginning of repolarization.
- **Na^+-K^+ pump:** The sodium-potassium pump works to bring back the resting membrane potential of -70mV by actively transporting Na^+ ions outside and K^+ ions inside.

Z: Hyper polarisation: There is a slight **overshoot** in the negative potential therefore this is called hyperpolarization. It is caused due to a **delay** in the **closure of K^+ gates** with respect to Na^+ gates. Thus K^+ ions diffuse out and potential gets even more negative than resting membrane potential. However the normal membrane potential is regained by Na^+—K^+ pump.

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Q. No. 5 (Page 3)

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Q. No. 6 (Page 1) **Type of muscles:**

Identification of given muscles:-

A: Cardiac muscle
B: Skeletal muscle
C: Smooth muscle.

There are a total of three types of muscles found in human body:

A: Cardiac muscle	B: Skeletal muscle	C: Smooth muscle:
(. shape):		
• They are branched in shape.	• They are cylindrical in shape.	• They are spindle shaped.
(. striations):		
• They are irregularly striped.	• They have regular striations.	• They do not possess striations.
(. number of nuclei):		
• One nucleus per cell.	• Multiple nuclei per cell	• One nucleus per cell
(. function):		
• To generate heartbeat.	• Movements of body parts and whole body.	• Movements of substances within internal organs.
(. location):		
• Present in heart	• Attached to bones.	• Present in internal organs (lining of respiratory, digestive and urinogenital system).
(. voluntary control):		
(no voluntary control) • Contraction occurs spontaneously.	• Have voluntary control	• No voluntary control.

Q. No. 6 (Page 2) (source of stimulation / contraction)

• The contraction of cardiac muscle occurs spontaneously.	• The contraction of skeletal muscle occurs by nervous stimulation.	• Contraction of smooth muscle caused by nervous stimulation.

(Section C)

Q. No. 6 (Page 3)

Space for rough work

Space for rough work

Space for rough work