Internal Assessment Test 2 –May 2025

| Sub: | **BIOLOGY FORCOMPUTERENGINEERS** | | | | | Sub Code: | BBOC407 | Branch: | ISE | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date: | **27/05/2025** | Duration: | 90 min's | Max Marks: | 50 | Sem/Sec: | IV A, B & C | | OBE | |

| **Answer any FIVE FULL Questions** | | MARKS | CO | RBT |
|---|---|---|---|---|
| 1. | Use a neat labeled diagram and explain the mechanism of filtration by the nephrons | 10 | CO3 | L2 |
| 2. | The structure and design of the Kingfisher's beak led to the design of the bullet trains. Interpret. | 10 | CO4 | L3 |
| 3. | Define EEG. Briefly explain the procedure of EEG. | 10 | CO3 | L2 |
| 4. | Explain echolocation using application of echolocation in ultrasonography | 10 | CO4 | L3 |
| 5. | Explain the working of Brain as a CPU | 10 | CO3 | L2 |
| 6.a | Write a short note on Bionic leaf | 10 | CO4 | L2 |
| 6.b | Write a short note on human blood substitutes | 10 | CO4 | L2 |

## 1. Use a neat labeled diagram and explain the mechanism of filtration by the nephrons.

**(10 Marks – CO3, L2)**

### Diagram of Nephron:

*(Since I can't draw here, please use a labeled diagram with the following parts: Bowman's capsule, Glomerulus, Proximal convoluted tubule, Loop of Henle, Distal convoluted tubule, Collecting duct, Afferent and Efferent arterioles)*

### Explanation:

The nephron is the functional unit of the kidney, and filtration primarily occurs in the **renal corpuscle**, which includes the **glomerulus** and **Bowman's capsule**.

- **Step 1: Glomerular Filtration**
    - Blood enters the **glomerulus** through the **afferent arteriole**.
    - Due to high pressure, **water, salts, glucose, amino acids**, and **urea** pass through the **capillary walls** into **Bowman's capsule**, forming **glomerular filtrate**.
    - Larger molecules like proteins and blood cells remain in the blood.
- **Step 2: Tubular Reabsorption**
    - Essential substances like glucose, amino acids, and most of the water are reabsorbed in the **proximal convoluted tubule** and **loop of Henle**.
- **Step 3: Tubular Secretion**
    - Additional waste products like $H^+$, $K^+$, and certain drugs are secreted into the tubule from surrounding capillaries.
- **Step 4: Formation of Urine**
    - The final filtrate, now called **urine**, flows into the **collecting duct** and ultimately into the **ureter**.

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**2. The structure and design of the Kingfisher's beak led to the design of the bullet trains. Interpret.**

**(10 Marks – CO4, L3)**

**Interpretation:**

The Kingfisher bird has a unique beak that allows it to **dive into water with minimal splash**, due to its **streamlined shape**. Engineers observed this **natural design** while working on **Japan's Shinkansen bullet train**, which faced a problem of loud sonic booms when exiting tunnels.

- **Problem:** Earlier train noses caused a loud boom due to rapid air displacement.
- **Solution:** Inspired by the Kingfisher's beak, engineers redesigned the train's nose to be **long and pointed**, reducing air resistance.
- **Outcome:** This led to:
    - **Quieter operation**

- **Increased speed**
- **Improved energy efficiency**

This is an example of **biomimicry**, where nature-inspired solutions are applied to engineering and design.

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**3. Define EEG. Briefly explain the procedure of EEG.**

**(10 Marks – CO3, L2)**

**Definition:**
EEG stands for **Electroencephalogram**. It is a test used to evaluate the **electrical activity of the brain** by detecting abnormalities in brain waves.

**Procedure:**

1. **Preparation:**
   - The patient is made to lie down comfortably.
   - **Electrodes** (small metal discs with thin wires) are attached to the scalp using a **conductive gel**.
2. **Recording:**
   - The electrodes detect electrical signals produced by neurons.
   - These signals are sent to a **computer** and recorded as **waveforms**.
3. **Duration:**
   - The procedure usually takes 20–40 minutes.
   - Sometimes, **stimuli** like light or breathing exercises are used to activate brain activity.
4. **Applications:**
   - Diagnose **epilepsy**, **sleep disorders**, **brain tumors**, and **brain death**.

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**4. Explain echolocation using application of echolocation in ultrasonography.**

**(10 Marks – CO4, L3)**

**Echolocation:**

- **Echolocation** is a biological sonar used by animals like **bats** and **dolphins** to navigate.
- They emit **sound waves** which reflect off objects and return as **echoes**, allowing them to judge **distance, size, and shape**.

**Application in Ultrasonography:**

- Medical ultrasonography (ultrasound scanning) uses the same principle.
- A **transducer** sends **high-frequency sound waves** into the body.
- The waves reflect off internal structures and are captured back.
- A computer converts these echoes into **real-time images**.

**Uses:**

- **Fetal imaging**
- **Diagnosing tumors and cysts**
- **Visualizing internal organs like liver, kidney, heart**

Thus, ultrasonography is a **technological application** of a natural phenomenon.

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**5. Explain the working of Brain as a CPU.**

**(10 Marks – CO3, L2)**

The brain functions like a **Central Processing Unit (CPU)** of a computer:

| Brain Function | CPU Equivalent | Description |
|---|---|---|
| **Cerebrum** | **Processor** | Performs logic, decision-making, memory storage |
| **Neurons** | **Circuits/Processors** | Transmit electrical signals |
| **Spinal Cord** | **Data bus** | Carries data between brain and body |
| **Sensory Organs** | **Input devices** | Eyes, ears send data to brain |
| **Muscles** | **Output devices** | Receive signals from brain |
| **Memory (Hippocampus)** | **RAM/Storage** | Stores short-term and long-term data |

Like the CPU processes inputs and sends outputs, the **brain interprets stimuli, makes decisions**, and sends responses through the nervous system.

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**6.a Write a short note on Bionic Leaf**

**(10 Marks – CO4, L2)**

**Bionic Leaf:**

- The **bionic leaf** is a **synthetic system** that mimics **natural photosynthesis**.
- Developed by scientists to **convert sunlight into fuel**, it uses:
  - **Solar energy**
  - **Bacteria**
  - **Water and carbon dioxide**

**Working:**

- The leaf splits water into **hydrogen and oxygen** using solar energy.
- Special bacteria then convert **hydrogen and $CO_2$ into fuels** like **isopropanol**.

**Applications:**

- **Sustainable energy**
- **Reducing carbon footprint**
- Potential use in **agriculture and remote energy generation**

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**6.b Write a short note on human blood substitutes**

**(10 Marks – CO4, L2)**

**Human Blood Substitutes:**

- Artificial substances that **mimic functions of real blood**, mainly **oxygen transport**.
- Used when **real blood is unavailable or incompatible**.

**Types:**

1. **Hemoglobin-Based Oxygen Carriers (HBOCs)**

2. **Perfluorocarbon-Based Carriers (PFCs)**

**Advantages:**

- **No blood typing required**
- **Long shelf life**
- Useful in **emergency medicine, military, remote areas**

**Limitations:**

- Limited ability to replace all blood functions.
- Research is ongoing to ensure **safety and effectiveness**.