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Internal Assessment Test 2 – July 2024									
Sub:	**Biology for Engineers**					Sub Code:	**BBOK407**	Branch:	**ECE**
Date:	**00/06/2024**	Duration:	90 Minutes	Max Marks:	50	Sem/Sec:	**3/A, B, C, D**		**OBE**

	Answer Any 5 Questions	MARKS	CO	RBT
1	Write a short notes Cataract, lens materials and bionic eye	[10]	CO3	L2
2	Deliberate the functioning of brain as CPU system.	[10]	CO3	L2
3	a. What are the reasons for blockages of blood vessels b. Explain about the design of stents	[10]	CO3	L2
4	Explain Kidney as a filtration system	[10]	CO3	L3
5	Explain with neat sketch about the architecture of rod & cone cells and the materials used for Lens Materials	[10]	CO3	L2
6	Illustrate the engineering solutions available for Parkinson's disease and assess their effectiveness in improving the quality of life for patients.	[10]	CO3	L2
7	a. Explain the gas exchange mechanisms in Human Lungs b. Explain about COPD and Ventilators	[10]	CO3	L2

1. Write a short notes on Cataract, lens material and bionic eye?

- A cataract is a clouding of the eye's natural lens, which lies behind the iris and the pupil.
- Cataracts usually develop in both eyes, but sometimes they only affect one. Most cataracts occur as a result of getting older, usually sometime after age 40.
- Cataracts are the most common cause of vision loss worldwide, but they are treatable.

Causes of cataracts

- As we age, the proteins that make up the eye's natural lens can clump together. These clumps are cataracts and are what cause cloudiness.
- Over time, they may grow larger and cloud more of the lens, making it harder to see.
- The lens inside the eye works much like a camera lens, focusing light onto the retina for clear vision. It also adjusts the eye's focus, letting us see things both up close and far away.
- Water and protein make up most of the lens of the eye. The protein is arranged in a precise way that keeps the lens clear and lets light pass through it.
- No one knows for sure why the eye's lens changes as we age, forming cataracts. Researchers worldwide have identified factors that may be related to cataract development.

Cataract symptoms

A cataract starts out small and, at first, has little effect on your vision. Visual symptoms can take months to years to become noticeable. You may notice that your vision is blurred a little, like looking through a cloudy piece of glass.

Cataracts can progress at a different rate in each eye, resulting in visual symptoms in one eye and normal vision in the other. You may also notice the following symptoms with cataracts:

- Light from the sun or a lamp seems too bright or glaring.
- Your eyes feel more sensitive to light.
- Oncoming headlights cause more glare than before when driving at night.
- Visual halos around bright lights.
- Double vision.
- Seeing at night or in low light is more difficult.
- Colors may not appear as bright as they once did.
- Blurry, cloudy, hazy or dim vision.
- **Types of cataracts**
- There are many cataract types, but a few are much more common than the others.
- ***Nuclear cataracts*** are the most common form of cataract. These form in the centre of the eye's lens, gradually worsening and affecting vision.
- ***Cortical cataracts*** usually are spoke-like opacities that begin near the edge of the lens and grow toward its centre. These make you experience more light glare, making night driving particularly difficult.
- ***Congenital cataracts*** are lens opacities that are present at birth in one or both eyes. They may be very small, with little effect on vision, or more severe.
- ***Trauma-induced cataracts*** can form anywhere on the lens and often develop into a flower-petal or "rosette" shape.
- ***Posterior sub-capsular cataracts*** develop at the central back surface of the lens. These types of cataracts tend to develop faster than the others. Symptoms usually affect your vision around bright light and colours.

Lens Materials

- Standard Glass
- Standard plastic
- Polycarbonate
- Trivex
- High-index materials

Standard Glass

- The glass had been the material most widely used for ocular lenses until the 1970s.
- Glass provides superior optical quality and has the most scratch-resistance surface, however, it has several limitations including heavyweight, increased thickness, and low impact resistance.
- Glass lenses must be treated to comply with the American National Standards Institute impact resistance standards.
- Chemical or thermal tempering can increase the shatter resistance, however, this effect is lost if the lens is scratched or worked on with any tool after tempering.
- Individuals with myopia who desire thin glasses may opt for high-index glass, however, the highest-index glass lenses cannot be tempered and require patients to sign a waiver accepting the risk of breakage.
- Additionally, high-index glass does not block ultraviolet light without a coating

Standard plastic

- Plastic lenses gained popularity in the 1970s and have the benefits of weighing half as much as glass lenses due to their lower specific gravity and high optical quality.
- R-39 which stands for Columbia resin #39 is the most commonly used plastic polymer lens material. The lenses block 80% of ultraviolet light without treatment, and can be tinted and coated to provide further ultraviolet light blocking.
- Plastic lenses tend to have a lower index of refraction, which require thicker lenses. The lens surface is also softer and thus easier to scratch, however, scratch-resistant coatings are available to create a harder surface. CR-39 lenses in particular do not have the shatter resistance of polycarbonate or Trivex, increasing risk to wearers.

Polycarbonate

- High index polycarbonate lenses were popularized in the 1980s due to their lightweight, thin profile, superior impact resistance, and ultraviolet protection.
- These lenses are often recommended for children, young adults, individuals with active lifestyles, and as safety eyewear. They are very durable and can be up to 30% thinner than regular glass or plastic lenses.
- Disadvantages include high chromatic aberration indicated by its low Abbe number, which results in colour fringing most noticeable in strong prescriptions. Additionally, polycarbonate is the most easily scratched plastic, thus requiring a scratch-resistant coating.

Trivex

- Trivex was introduced in 2001 and is a highly impact-resistant material with a low specific gravity delivering strong optical quality and minimal chromatic aberration indicated by its high Abbe number.

- Trivex is also able to block nearly all ultraviolet light. A disadvantage of Trivex lenses is their low index of refraction, thus requiring thicker lenses for higher powers.
- At the ±3.00 Diopter prescription range, this material allows for a comparably thin lens. Trivex is the lightest material available and meets high-velocity impact standards. A scratch-resistant coating is required for this lens.

High-index materials

- High-index materials are defined by a refractive index of 1.60 or higher and can be either glass or plastic.
- The main utility of high-index lenses is for high-power prescriptions to create thin and cosmetically attractive lenses.
- The weight, optical quality, and impact resistance of high-index lenses vary based on the material used. For high-index glass, the specific gravity tends to run high, which means that these lenses are often heavy compared to other materials.
- None of the high-index materials passes the American National Standards Institute's impact resistance standards.

Bionic eye

- A bionic eye is not the same thing as a prosthetic eye. Prosthetic eyes (also called "glass eyes" or "artificial eyes") replace the physical structure and appearance of an eye that must be removed due to trauma, pain, disfigurement or disease. Bionic eye implants, on the other hand, work inside the existing eye structures or in the brain. They are designed to achieve functional vision goals — as opposed to physical, cosmetic ones. The process of sight begins when light enters the eye. The cornea and lens focus light onto the retina at the back of the eyeball.
- Light-sensitive cells in the retina then convert the focused light into electrical energy, which is transported to the brain via the optic nerve.
- In blind people, part of this process doesn't work. In some cases, the cornea or lens are damaged or diseased, or the retina can't perceive light. In others, the signal is lost somewhere along the visual pathway in the brain.
- Different bionic eye models take aim at different target areas in the visual pathway.
- Currently, retinal implants are the only approved and commercially available bionic eyes, though cornea transplants and cataract surgery can replace the cornea and lens if these structures are clouded or are incapable of focusing light for other reasons.

2. Deliberate the functioning of Brain as a CPU system?

- The human brain can be thought of as a highly sophisticated and complex information processing system, similar to a computer's Central Processing Unit (CPU).

- Both the brain and CPU receive and process inputs, store information, and perform calculations to produce outputs.
- However, there are significant differences between the two, such as the way they store and process information and the fact that the human brain has the ability to learn and adapt, while a computer's CPU does not.
- Additionally, the human brain is capable of performing tasks such as perception, thought, and emotion, which are beyond the scope of a computer's CPU.

BASIS OF COMPUTER	BRAIN	COMPUTER
Construction	Neurons and synapses	ICs, transistors, diodes, capacitors, transistors, etc
Memory growth	Increases each time by connecting synaptic links	Increases by adding more memory chips
Backup systems	Built-in backup system	Backup system is constructed manually
Memory power	100 teraflops (100 trillion calculations/seconds)	100 million megabytes
Energy consumption	12 watts of power	Gigawatts of power
Information storage	Stored in electrochemical and electric impulses.	Stored in numeric and symbolic form (i.e. in binary bits).

BASIS OF COMPUTER	BRAIN	COMPUTER
Transmission of information	Uses chemicals to fire the action potential in the neurons.	Communication is achieved through electrical coded signals
Information processing power	Low	High
Input/output equipment	Sensory organs	Keyboards, mouse, web cameras, etc
Structural organization	Self-organized	Pre-programmed structure
Parallelism	Massive	Limited
Reliability and Damageability properties	Brain is self-organizing, self maintaining and reliable.	Computers perform a monotonous job and can't correct itself

3. Write the reason for blockage of blood vessels?

Blockages in blood vessels, also known as arterial blockages or atherosclerosis, can occur for several reasons:

1. High cholesterol levels: Excessive amounts of low-density lipoprotein (LDL) cholesterol in the blood can lead to the formation of plaque in the blood vessels, which can narrow or block them.

2. High blood pressure: Over time, high blood pressure can cause damage to the blood vessels, leading to the formation of plaque and blockages.
3. Smoking: Smoking can damage the inner walls of blood vessels and promote the buildup of plaque, leading to blockages.
4. Diabetes: People with uncontrolled diabetes are at a higher risk of developing blockages in their blood vessels, due to damage to the blood vessels from high levels of glucose.
5. Age: As people age, the blood vessels can become stiff and less flexible, increasing the risk of blockages.
6. 6. Genetics: Some people may be predisposed to developing blockages in their blood vessels due to genetic factors.
7. 7. Poor diet: A diet high in saturated fats, trans fats, and cholesterol can increase the risk of developing blockages in the blood vessels.
8. The blockages in blood vessels can have serious health consequences, such as heart attacks and stroke. Maintaining a healthy lifestyle, including eating a healthy diet, exercising regularly, and avoiding smoking, can help reduce the risk of developing blockages in blood vessels.

Design of Stents

Stents are small, metal mesh devices that are used to treat blockages in blood vessels.

They are typically used in procedures such as angioplasty, where a balloon catheter is used to open up a blocked blood vessel and a stent is placed to keep it open.

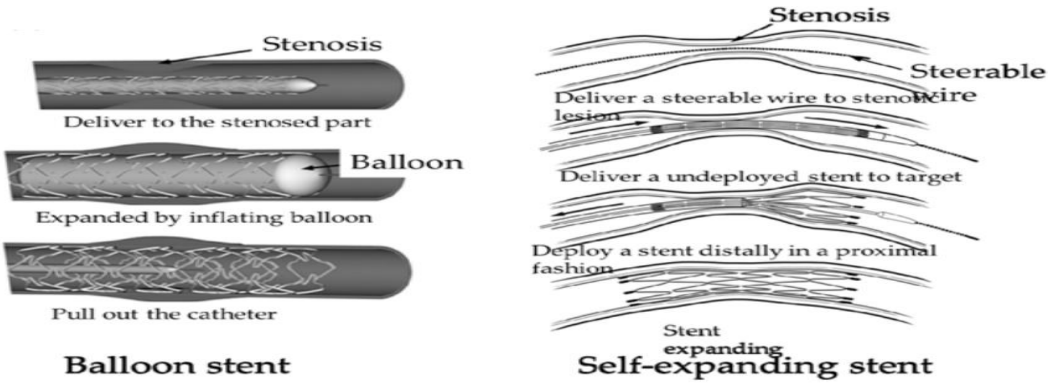


Figure: Representing the working of balloon stent and self-expanding stent

The design of stents can vary depending on the type of stent and the specific medical condition it is used to treat.

Some common design features of stents include:

Shape: Stents can be designed in a variety of shapes, including cylindrical, helical, and spiraled, to match the shape of the blood vessel and provide adequate support.

Material: Stents can be made of different materials, including stainless steel, cobalt, chromium, and nitinol (a type of metal that is flexible and can return to its original shape after being expanded).

Coating: Stents can be coated with different materials to prevent blood clots from forming and reduce the risk of restenosis (recurrent blockage of the blood vessel).

Expansion mechanism: Stents can be designed to expand in different ways, such as by balloon inflation or self-expansion, depending on the type of stent and the specific medical condition it is used to treat.

Overall, the design of stents plays an important role in their effectiveness and safety. Stents must be designed to provide adequate support to the blood vessel, prevent restenosis, and minimize the risk of complications such as blood clots

4. Explain kidney as a filtration system?

- The kidney is a complex organ that acts as a filtration system for the body.
- It removes waste and excess fluid from the bloodstream and maintains a delicate balance of electrolytes, hormones, and other substances that are critical for the body's normal functioning.
- The kidney also plays an important role in *regulating blood pressure* by secreting the *hormone renin*, which helps control the balance of fluid and electrolytes in the body.
- It also *regulates red blood cell production* and the levels of *various minerals* in the *blood, such as calcium and phosphorus*.
- Without the kidney, waste and excess fluid would accumulate in the body, leading to serious health problems.
- The kidney is composed of functional units called nephrons, which are the basic structural and functional units of the kidney.
- Each kidney contains approximately one million nephrons, and each nephron performs the functions of filtration, reabsorption, and secretion.
- The nephron is comprised of several key structures:
- Bowman's capsule: This is a cup-shaped structure that surrounds the glomerulus and filters waste and excess fluid from the bloodstream into the renal tubule.
- Glomerulus: A network of tiny blood vessels within the Bowman's capsule that filters waste and excess fluid from the bloodstream.
- Proximal convoluted tubule: A segment of the renal tubule that reabsorbs important substances, such as glucose, amino acids, and electrolytes, back into the bloodstream.
- Loop of Henle: A U-shaped segment of the renal tubule that is critical for the reabsorption of ions and water.
- Distal convoluted tubule: A segment of the renal tubule that regulates the levels of electrolytes and other important substances in the bloodstream.

- Collecting duct: A series of ducts that collect the filtrate from the renal tubules and transport it to the renal pelvis, where it drains into the ureter and eventually into the bladder.

The nephrons are surrounded by a network of blood vessels, including the afferent arteriole and the efferent arteriole, which bring blood into and out of the glomerulus, respectively. The filtrate produced by the nephron passes through the renal tubules, where it is modified by reabsorption and secretion, before being eliminated from the body

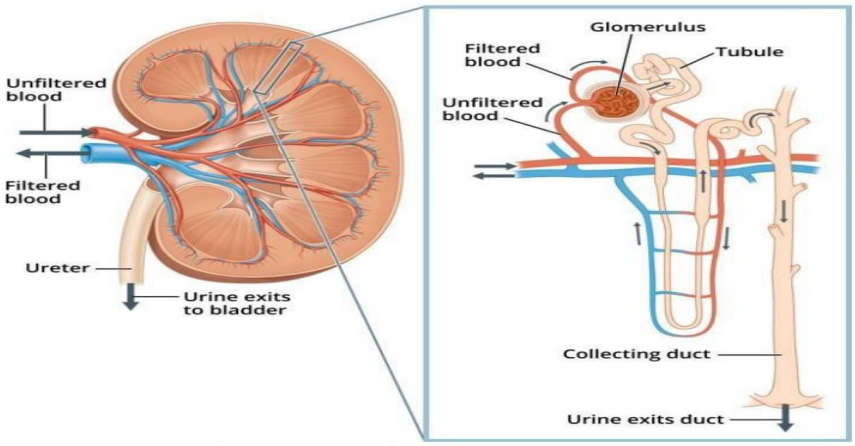


Figure: Representing kidney and nephron

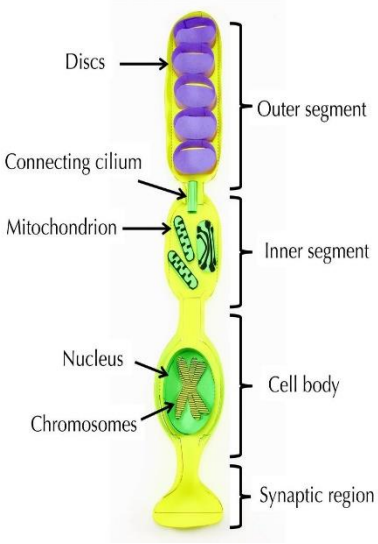
- The mechanism of filtration in the kidneys is a complex process that involves multiple steps to remove waste and excess fluids from the bloodstream.
- The following is a summary of the steps involved in the filtration process:
- Blood enters the kidney through the renal arteries and flows into tiny filtering units called glomeruli.
- At the glomerulus, the pressure in the blood vessels causes a portion of the plasma and dissolved substances to filter out and enter a structure called Bowman's capsule.
- In Bowman's capsule, the filtrate is then transferred into the renal tubules, which are the main filtering units of the kidneys.
- In the renal tubules, the filtrate passes through a series of specialized cells, such as proximal tubular cells and distal tubular cells, which reabsorb important substances such as glucose, amino acids, and electrolytes back into the bloodstream.
- At the same time, the renal tubules secrete waste products, such as urea and creatinine, back into the filtrate.
- Finally, the filtered fluid, now known as urine, is transported through the renal pelvis and ureters to the bladder, where it is eventually eliminated from the body. This process of filtration, reabsorption, and secretion helps to maintain the proper balance of fluids and electrolytes in the body, as well as to remove waste and excess substances.

5. Architecture of rods and cones of cells and materials used for lens?

Rods

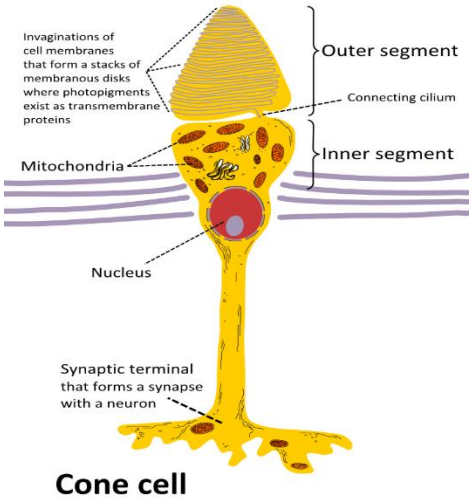
Rods are cylindrical-shaped photoreceptors. They are more numerous than cone cells, with an estimated 92 million rod cells located in the human retina. They function best in low-intensity light (scotopic) and are thus responsible for vision in dimly lit surroundings, such as at dusk. Rod outer segments are cylindrical in shape, consisting of around 1000 flat, lobulated, membranous discs.

- The inner segment of the rod cell is divided into an outer mitochondria-rich part and an inner part containing endoplasmic reticulum. The structure of the rod cell is consistent across all areas of the retina.
- Rod cells are located across the retina except at the center of the fovea.
- The density of rod cells increases as you move away from the fovea, reaching a peak and declining again towards the periphery.
- Rod vision provides high sensitivity to light, but with relatively low spatial discrimination and no ability to distinguish different wavelengths of light. This is why they are not capable of detecting different colour. Compared to cone cells, rods have poor visual acuity, or the ability to distinguish fine detail.



Cones

- Cones are conical-shaped cells that operate best in high-intensity lighting (photonic) and are responsible for the perception of colour.
- There are far fewer cone cells in the human retina compared to rod cells, numbering approximately 4.6 million.
- Cone outer segments are generally shorter than that of rods and, as their name implies, are often conical. As is the case of rod cells, the inner segment of the cone cells has an outer mitochondria-rich part and an inner part containing endoplasmic reticulum.



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7. Illustrate the engineering solutions available for Parkinsons disease and assess their effectiveness in improving the quality of life for patients.

Parkinson's disease is a neurodegenerative disorder that affects movement and motor function. There are several engineering solutions aimed at improving the quality of life for individuals with Parkinson's disease, including:

- Deep Brain Stimulation (DBS): DBS involves the implantation of electrodes into specific regions of the brain to deliver electrical stimulation, which can help to relieve symptoms such as tremors, stiffness, and difficulty with movement.

- Exoskeletons: Exoskeletons are wearable devices that provide support and assistance for individuals with mobility issues. Some exoskeletons have been developed specifically for people with Parkinson's disease, and can help to improve balance, reduce tremors, and increase overall mobility.

- Telerehabilitation: Telerehabilitation involves the use of telecommunication technology to provide physical therapy and rehabilitation services to individuals with Parkinson's disease, without the need for in-person visits to a therapist.

- Smartwatch Applications: Smartwatch applications can be used to monitor symptoms of Parkinson's disease, such as tremors, and provide reminders and prompts for medication and exercise.

- Virtual Reality: Virtual reality systems can be used for rehabilitation and therapy for individuals with Parkinson's disease, providing interactive and engaging environments for patients to practice movements and improve coordination and balance.

These engineering solutions have the potential to significantly improve the quality of life for individuals with Parkinson's disease, and ongoing research and development is aimed at improving their effectiveness and accessibility.

However, it is important to note that these technologies are not a cure for Parkinson's disease and should be used in conjunction with other forms of treatment and care.

7. Gas Exchange Mechanisms:

The gas exchange mechanism in the lung involves the transfer of oxygen from the air in the alveoli to the bloodstream, and the transfer of carbon dioxide from the bloodstream to the air in the alveoli. This process is known as diffusion and occurs due to differences in partial pressures of oxygen and carbon dioxide.

Oxygen Diffusion: The partial pressure of oxygen in the air in the alveoli is higher than the partial pressure of oxygen in the bloodstream. This difference creates a gradient that causes oxygen to diffuse from the alveoli into the bloodstream, where it binds to hemoglobin in red blood cells to form oxyhemoglobin.

Carbon Dioxide Diffusion: The partial pressure of carbon dioxide in the bloodstream is higher than the partial pressure of carbon dioxide in the air in the alveoli. This difference creates a gradient that causes carbon dioxide to diffuse from the bloodstream into the alveoli, where it is exhaled.

COPD:

Chronic Obstructive Pulmonary Disease Chronic Obstructive Pulmonary Disease (COPD) is a group of progressive lung diseases that cause breathing difficulties. It's characterized by persistent airflow limitation that is not fully reversible. The two main forms of COPD are chronic bronchitis and emphysema. In COPD, the airways and small air sacs (alveoli) in the lungs become damaged or blocked, leading to difficulty in exhaling air. This results in a decrease in lung function, leading to shortness of breath, wheezing, and coughing. Over time, these symptoms can get worse and limit a person's ability to perform everyday activities. The primary cause of COPD is long-term exposure to irritants such as tobacco smoke, air pollution, and dust. Other risk factors include a history of frequent lung infections, a family history of lung disease, and exposure to second-hand smoke. There is no cure for COPD, but treatment can help manage the symptoms and slow the progression of the disease. Treatment options include medication, such as bronchodilators and steroids, oxygen therapy, and lung rehabilitation. In severe cases, surgery may also be an option. In addition, quitting smoking and avoiding exposure to irritants is crucial in managing COPD.

Ventilators:

Ventilators are medical devices used to assist or control breathing in individuals who are unable to breathe adequately on their own. They are commonly used in the treatment of acute respiratory failure, which can occur as a result of a variety of conditions such as pneumonia, severe asthma, and chronic obstructive pulmonary disease (COPD).

There are several different types of ventilators, including volume-controlled ventilators, pressure controlled ventilators, and bilevel positive airway pressure (BiPAP) devices. The type of ventilator used depends on the patient's individual needs and the type of respiratory failure being treated. Ventilators work by delivering pressurized air or oxygen into the lungs through a breathing tube or mask. The pressure can be adjusted to match the patient's needs and to help maintain adequate oxygen levels in the blood. While ventilators can be lifesaving for individuals with acute respiratory failure, they also come with potential risks and complications. For example, prolonged use of a ventilator can increase the risk of ventilator-associated pneumonia, and patients may experience discomfort or pain from the breathing tube. The use of ventilators is carefully monitored and managed by healthcare professionals to ensure that the patient receives the appropriate level of support while minimizing potential risks and complications.