4) The light signal reaching the retina is transformed into an electrical impulse:

4.1 Identify photoreceptors cells as those containing light sensitive pigments and explain that these cells convert light images into electrochemical signals that the brain can interpret –

- **Photoreceptor Cells contain light sensitive pigments and convert light into electrochemical signals that the brain can interpret**
- **An Electrochemical Signal consists of a wave of Na^+ and K^+ ions that move across the cell membrane of the neurone**
- Once light is focused on the retina, the light signal is transformed into an electrochemical impulse and carried by the optic nerve to brain, which interprets the impulse as an image

Steps involved in Transformation of a Light Image to an Image in the Brain:

1. **Light image strikes retina and is absorbed by photosensitive pigments in rods and cones**
2. **A photochemical change in the rods and cones, involving visual pigments, generates an electrochemical impulse**
3. **This impulse is transmitted to bipolar cells in the retina, which receive the impulse**
4. **Bipolar cells stimulate ganglion cells, whose structures (axons) make up the optic nerve**
5. **Axons of the ganglion cells form the optic nerve and carry partly processed information to the brain**

5 Layers of Nerve Cells (Neurones) Involved in Transmission of Impulses in the Retina:

1. **The Photoreceptor Cell Layer:**
   - ❖ **The rods and cones, when stimulated by light, perform 3 main functions:**
     - i. **Absorb light energy (involving the visual pigments)**
     - ii. **Convert light energy → electrochemical energy, generating nerve impulses**
     - iii. **Transmit this nerve impulse towards the bipolar cells of the retina**
2. **The Bipolar Cell Layer:**
   - ❖ **These sensory neurones receive electrochemical signals from rods & cones and transmit it from these photoreceptors to the ganglion layer of cells**
3. **The Ganglion Cell Layer:**
   - ❖ **Neurones in this layer receive electrochemical signals from the bipolar cells**
   - ❖ **The distal end of the ganglion cells is extended into long processes (structures) that form the fibres of the optic nerve**
   - ❖ **Function of these neurones is to carry electrochemical signals from retina to brain**
4. **Associated Horizontal Cells:**
   - ❖ **Horizontal cells occur at the junction between photoreceptors and bipolar cells**
   - ❖ **They connect one group of rod & cone cells with another, & link them to bipolar cells**
5. **Associated Amacrine Cells:**
   - ❖ **These cells occur at the junction between bipolar and ganglion cells**
   - ❖ **Studies suggest that horizontal and amacrine cells are involved in processing or 'summarising' incoming visual information**

4.3 Outline the role of rhodopsin in rods –

- **Rhodopsins are visual (photochemical) pigments only present in rods, consisting of a protein molecule (opsin) bonded with a light-absorbing part called retinal (or retinene)**
- Retinal is derived from Vitamin A (Carotene) → if this is lacking, vision is affected and 'night blindness' results (retinal exists in a deactivated state)
- **MAIN ROLE OF RHODOPSIN IN RODS IS TO ABSORB LIGHT (CONSISTS OF OPSIN & RETINAL)**

Rhodopsin Functioning:

1. **When light strikes the rhodopsin pigment, light energy is absorbed and rhodopsin changes from its resting state to an excited state thus retinal becomes activated**
2. **This causes rhodopsin to split into its protein-opsin part and a free-retinal part** → this change is temporary
3. **The activated pigment causes a change in electrical charges (generates a potential difference) of the membrane of the cone (photoreceptor) → this starts an electrical impulse that moves along the receptor, triggering the release of a neurotransmitter**
4. **The neurotransmitter then stimulates a bipolar cell, generating an impulse in this cell. The signal is termed electrochemical as it involves both an electrical change in membrane and a chemical release of a neurotransmitter**
5. **The bipolar cell transmits the electrochemical signal to the ganglion cells which carry the signal to the brain**

The temporarily broken down Rhodopsin is regenerated using ATP for reuse → retinal and opsin recombine in the presence of an enzyme, allowing a new image to be perceived (Vitamin A presence is essential for the regeneration of Rhodopsin)

7) Signals from the eye and ear are transmitted as electro-chemical changes in the membranes of the optic and auditory nerves:

7.1 Identify that a nerve is a bundle of neuronal fibres –

- Nerve Cells/Neurones are small units that compose the nervous system
- **A Nerve is a bundle of axons (neuronal fibres) with blood vessels and connective tissue → they are specialised cells that transmit signals from one location in body to another via electrochemical changes in their membrane**
- **3 Basic Parts of all Neurones:**
    1. **A Cell Body (forming the grey matter of CNS), containing nucleus & cell organelles**
    2. **One or more fine branching extensions called Dendrites → conduct nerve impulses towards cell body. In sensory neurones, a single dendrite is called a Dendron**
    3. **One single, very long extension called an Axon (forming the white matter of the CNS) → conducts impulses away from cell body. Has many vertebrates surrounded by schwann cells (supporting cells that form an insulating layer)**
- **3 Types of Neurones:**
    1. **Sensory Neurones** → transmit impulses from sense organs to neurones in the CNS
    2. **Motor Neurones** → transmit impulses from the CNS to muscles and glands
    3. **Connect Neurones** → connect sensory neurones with motor neurones (usually in brain and spinal cord)