Communication & Signalling

Multicellular organisms

Cells in multicellular organism communicate using **extracellular signalling** molecules

Signal Molecule Examples

1. Steroid Hormones (testosterone & oestrogen)
2. Peptide Hormones (insulin)
3. Neurotransmitters

General Mechanism

1. Receptor molecules are **proteins** found on the surface of the plasma membrane or within the cytosol/nucleus of the target cell.

2. These receptors have a binding site for a **specific** extracellular signal molecule

3. The binding of the signal molecule (ligand) changes the **conformation** of the receptor

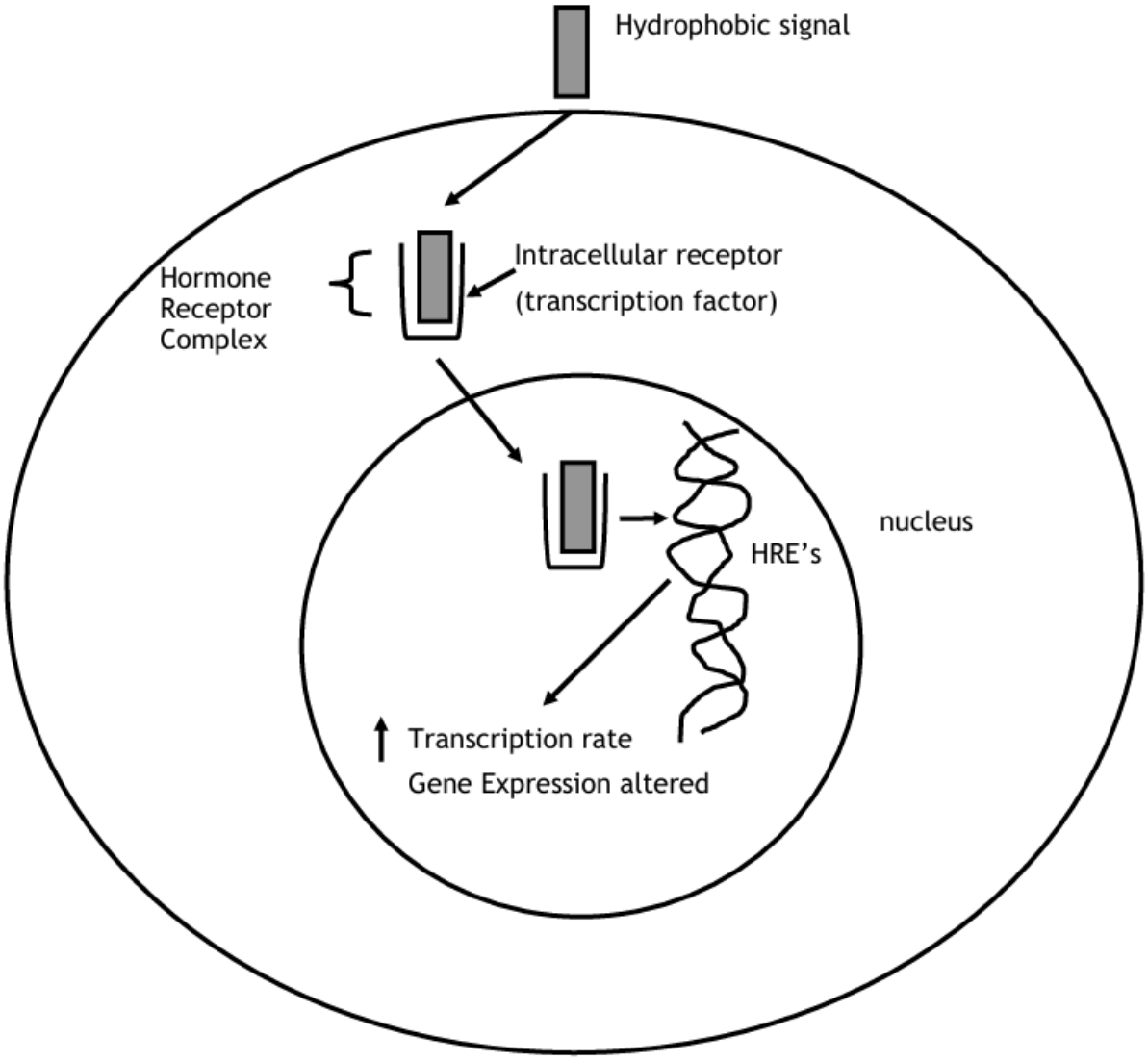
4. This initiates an **intracellular response** within the cell.

Type of Signalling Molecule	Molecule can pass through membrane	Location of receptor	Examples of extracellular signal
Hydrophilic	no	Plasma membrane	Peptide hormones (insulin) Neurotransmitters
Hydrophobic	yes	Cytosol or nucleus	Steroid Hormones (testosterone and oestrogen)

Hydrophobic Signalling

Extracellular hydrophobic signals (steroid hormones oestrogen/ testosterone)

1. Hydrophobic signalling molecules can diffuse directly through the phospholipid bilayers of membrane
2. They bind to specific intracellular receptors (transcription factors) found in the cytosol/nucleus forming the hormone receptor complex.
3. The hormone-receptor complex moves to the nucleus where it binds to specific sites on DNA called hormone response elements (HREs).
4. This influences the rate of transcription affecting the gene expression of many different genes.



Hydrophilic Signalling

Extracellular hydrophilic signals (peptide hormones/neurotransmitters)

1. These signal molecules (ligands) **cannot enter the cytosol** but instead bind to the extracellular face of transmembrane surface receptors, changing their conformation.

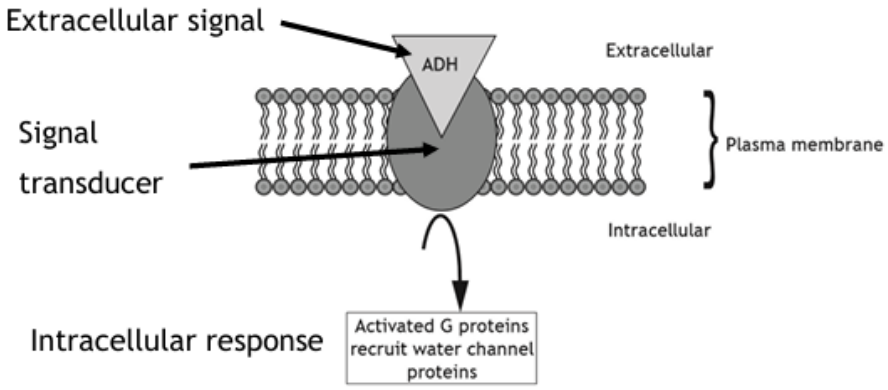
2. The activated transmembrane receptors then act as a **signal transducers** by converting the extracellular ligand-binding event into intracellular signals i.e. transducing the signa;/

3. These intracellular signals involve **G proteins** or **cascades of phosphorylation** by kinases

   (a) G protein intracellular Mechanism

   G-proteins relay signals from activated receptors to target proteins

   (enzymes/ ion channels)



(b) Phosphorylation cascade Intracellular Mechanism

One kinase activates the next in the sequence through phosphorylation. These cascade result in

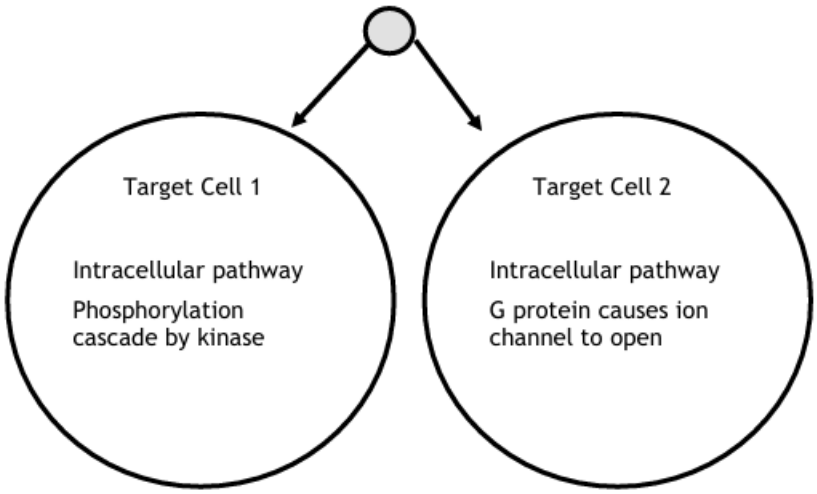
(i) Phosphorylation of many proteins as a result of the original signalling event.

(ii) Activation of more than one intracellular signalling pathway

Communication & Signalling

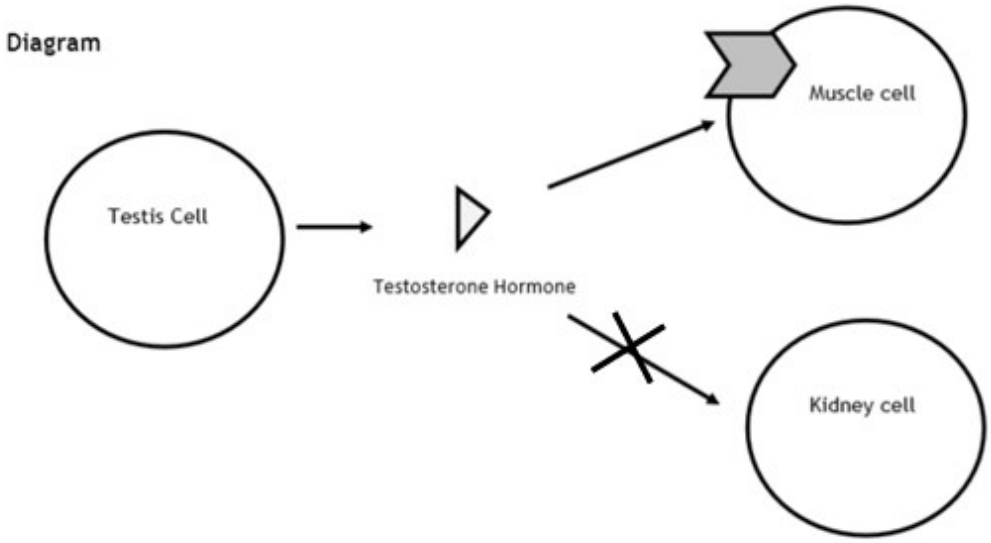
Tissue Specific Response

The **same signal** may have **different effects** on different target cell types due to differences in the **intracellular signalling molecules/pathways** .



Target vs Non Target Cells

Different cells produce specific signals that can only be detected and responded to by cells with the **specific receptor**



Hydrophilic Signalling: Insulin and Diabetes Mellitus

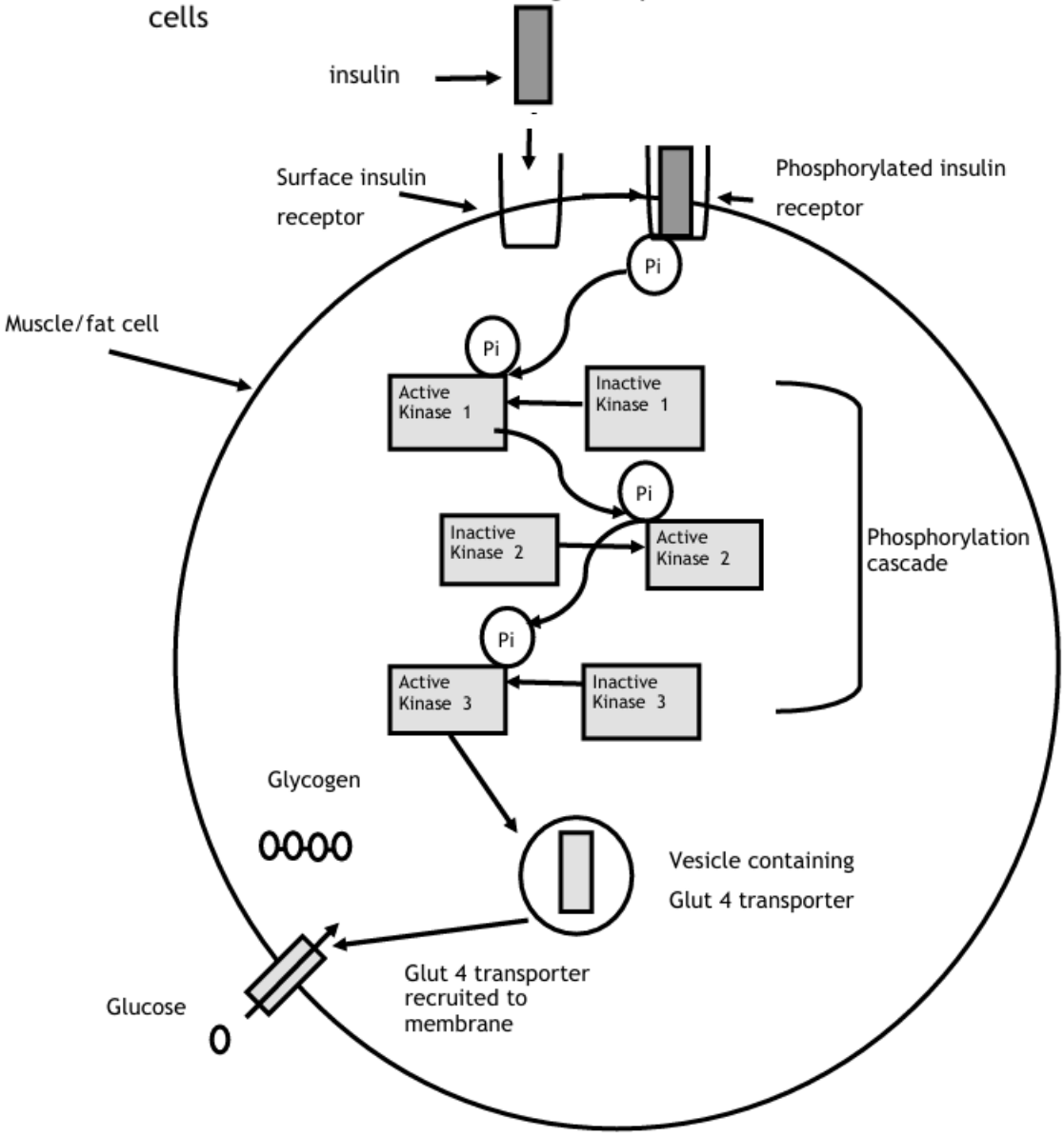
Insulin Signalling Mechanism

1. Insulin cannot enter the cytosol but instead binds to the extracellular face of its **transmembrane surface insulin** receptor on muscle/fat cells.

2. This causes a **conformational change** in the insulin receptor that triggers a **phosphorylation cascade** as the intracellular response.

3. The insulin receptor is phosphorylated and acts as a kinase by phosphorylating the next kinase in the series of reactions.

4. This phosphorylation cascade eventually causes **GLUT4 glucose transporter proteins** contained within vesicles being transported to the cell membrane of fat and muscle cells



Hydrophilic Signalling: Insulin and Diabetes Mellitus

Diabetes mellitus

Type 1
Failure to produce insulin

Type 2
Loss of receptor function
Generally associated with obesity

Solution
Exercise triggers recruitment of GLUT4 improving glucose uptake in fat/ muscle cells