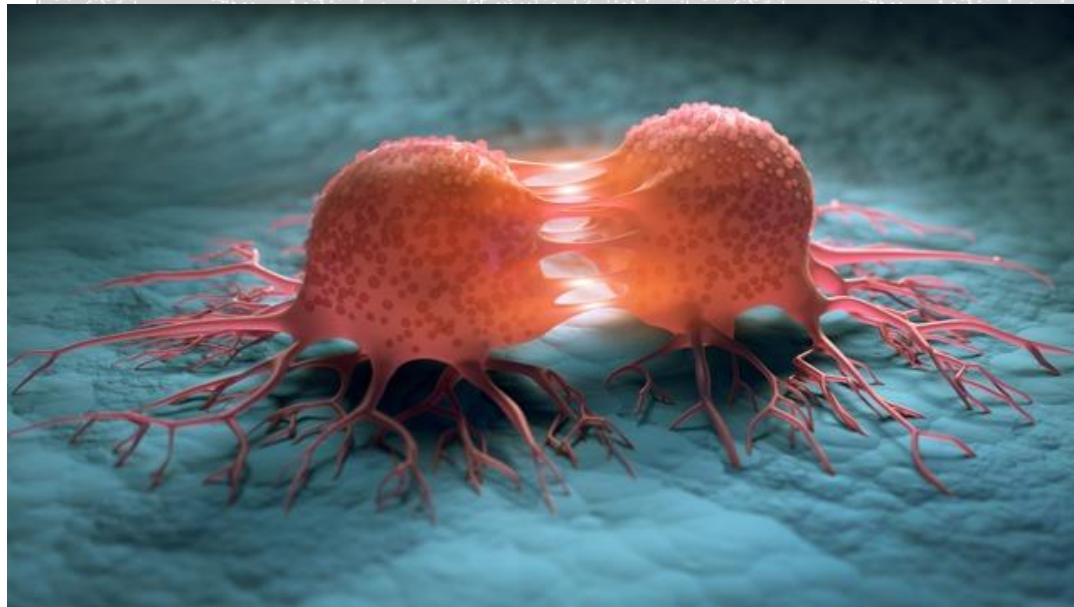


METABOLISM & CELL COMMUNICATION

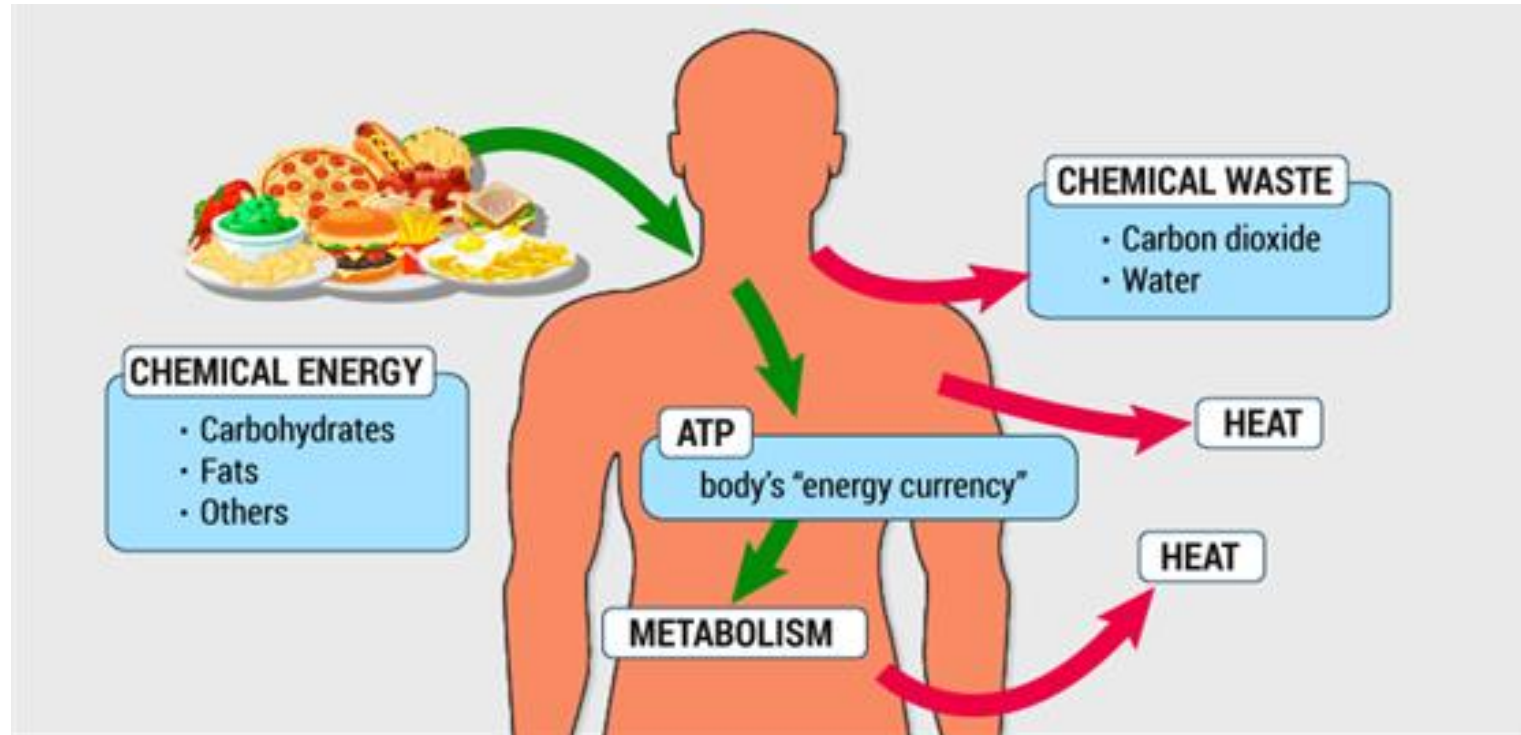


Dr. Manu Smriti Singh

Department of Biotechnology

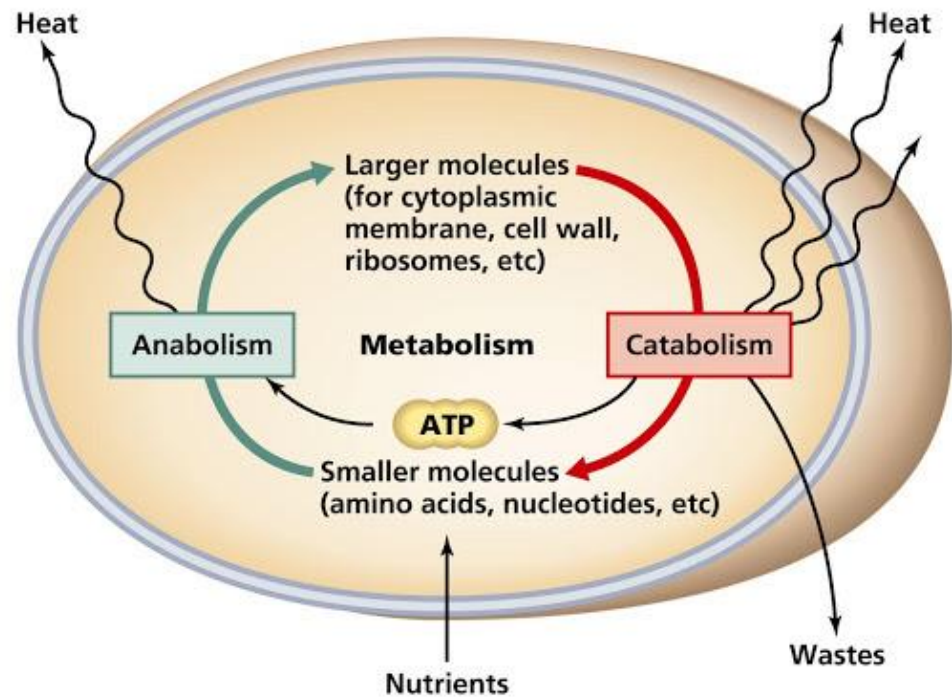
Bennett University

METABOLISM



All the chemical processes that take place in the body in order to sustain life- allowing you to breathe, pump blood, keep your brain functioning and extract energy from your food.

METABOLITES



Primary Metabolites:

Enzymes, Vitamins, Lactic Acid, Proteins, Lipids, Carbohydrates

Secondary Metabolites:

Steroids, Essentials Oils, Pigments, Antibiotics, Flavonoids, Gums/ Latex/ Tannins

The reactants, intermediates and products of metabolic pathways are referred to as metabolites

SECONDARY METABOLITES

- Also called specialized metabolites, toxins or natural products, are organic compounds produced by bacteria, fungi, or plants which are not directly involved in the normal growth, development, or reproduction of the organism.
- Mediate ecological interactions, which may produce a selective advantage for the organism by increasing its survivability or fecundity.
- Specific within a phylogenetic group.
- Secondary metabolites often play an important role in plant defense against herbivory and infections.
- Humans use secondary metabolites as medicines, flavorings, pigments, and recreational drugs



	Primary Metabolites	Secondary Metabolites
DEFINITION	Primary metabolites are compounds that are essential and directly involved in the growth, development and reproduction of an organism	Secondary metabolites are the end products that are not directly involved in the growth, development and reproduction of an organism
AMONG ORGANISMS	Most primary metabolites are identical among most organisms	Secondary metabolites are numerous and widespread
ORIGIN	Produced during the growth phase of the cell	Produced during the non-growth phase of the cell
QUANTITY	Produced in large quantities	Accumulated by plant cells in very small quantities than primary metabolites
PHASE OF PRODUCTION	The growth phase where primary metabolites are produced is sometimes called 'trophophase'	The phase during which secondary metabolites are made is called 'idiophase'
INVOLVEMENT IN DEFENSE REACTIONS	Do not participate in defense reactions	Most secondary metabolites participate in defense reactions
EXAMPLE	Proteins, carbohydrates, and lipids are the main primary metabolites	Alkaloids, phenolics, sterols, steroids, essential oils and lignins, are several secondary metabolites

METABOLITES IN USE

Secondary Metabolites:

Plant-Taxol/ Quinine/ Tannin/ Caffeine/ Nicotine
 Bacteria- Botulin
 Fungi- Penicillin

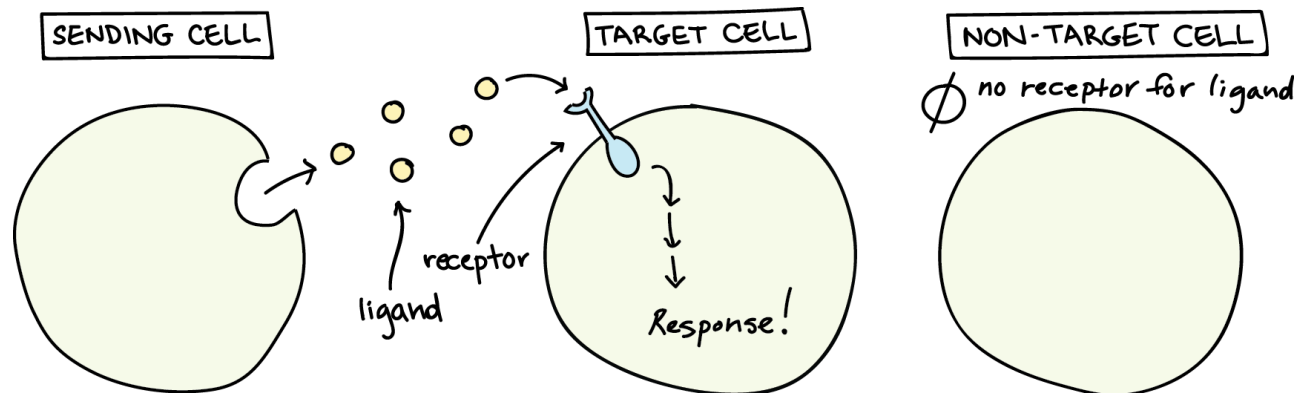
CELLS TALK IN CODES

Some UNIVERSAL PRINCIPLES of cell communication are now well known

- cells may use many different signal molecules including gas (NO)
- but only a few mechanisms have survived throughout evolution.

In multi-cell organisms cell-to-cell contact is critical.

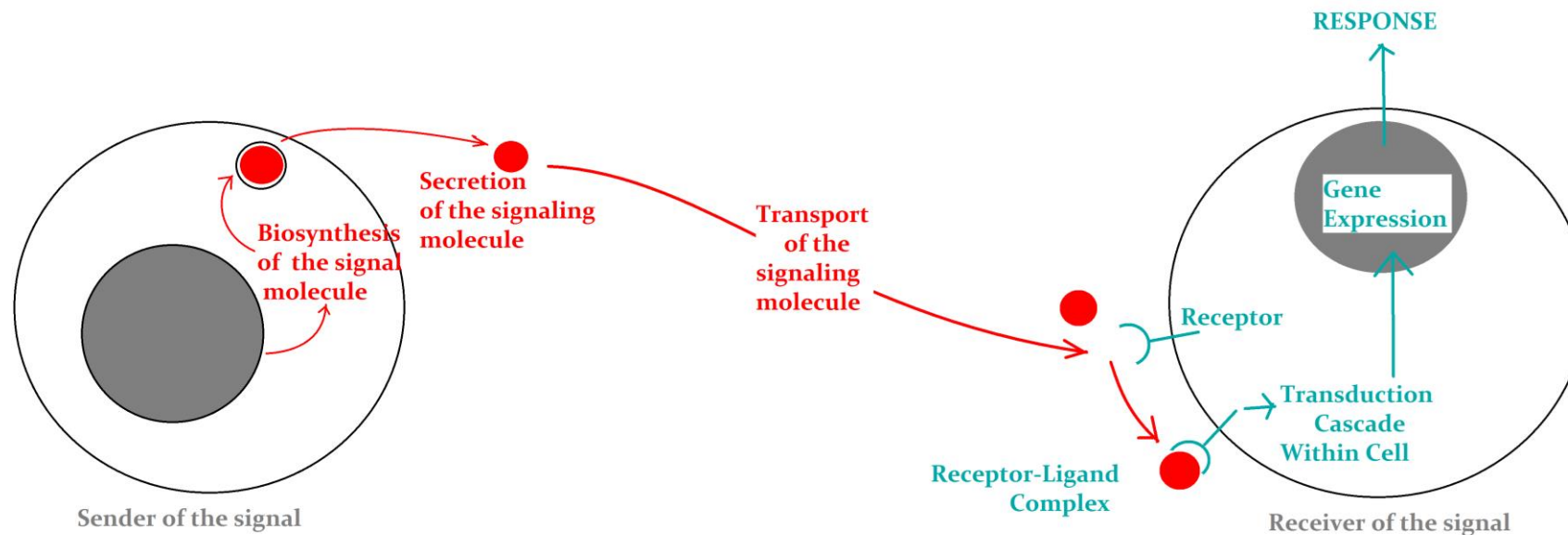
- cell membranes contain specific protein-receptors, which bind & transmit extra-cellular signal molecules converting signals into specific cellular responses.



Specificity!

WHY DO CELLS SIGNAL?

- Regulate gene expression- (Vitamin D, Thyroid)
- Warn of possible infection
- Regulate metabolism
- Allow enzyme secretion in stomach
- Relay messages to-and-from brain-to-body and vice versa
- Fight or flight reaction



RECEPTORS

- 0.01% of the total mass of protein in a cell
- Search through:
 1. Gene analysis
 2. Monoclonal antibodies

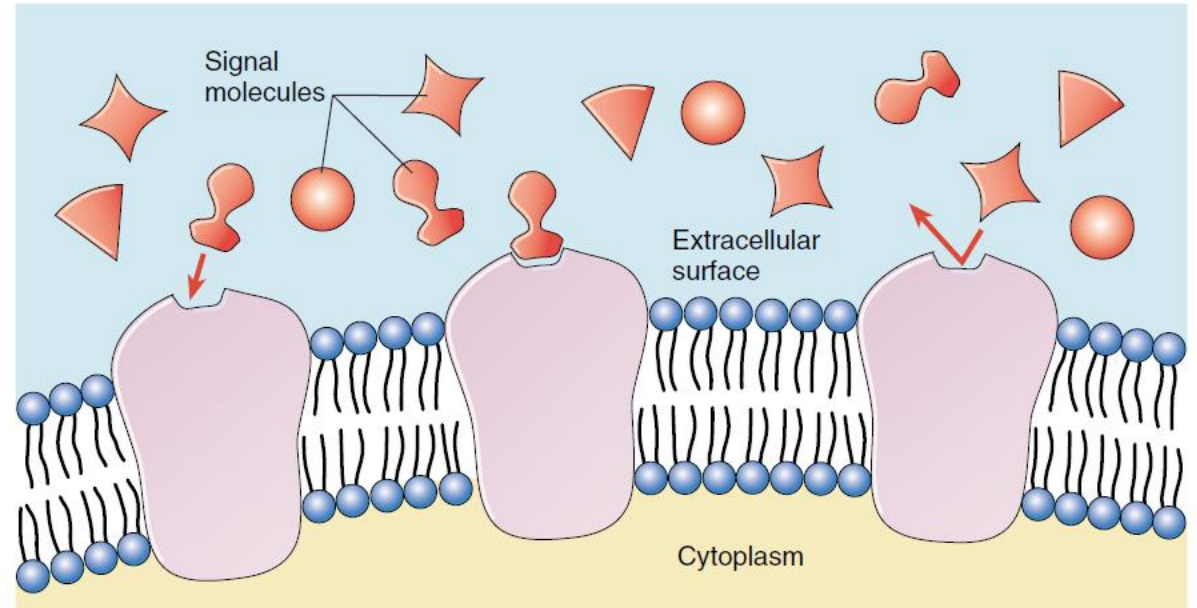
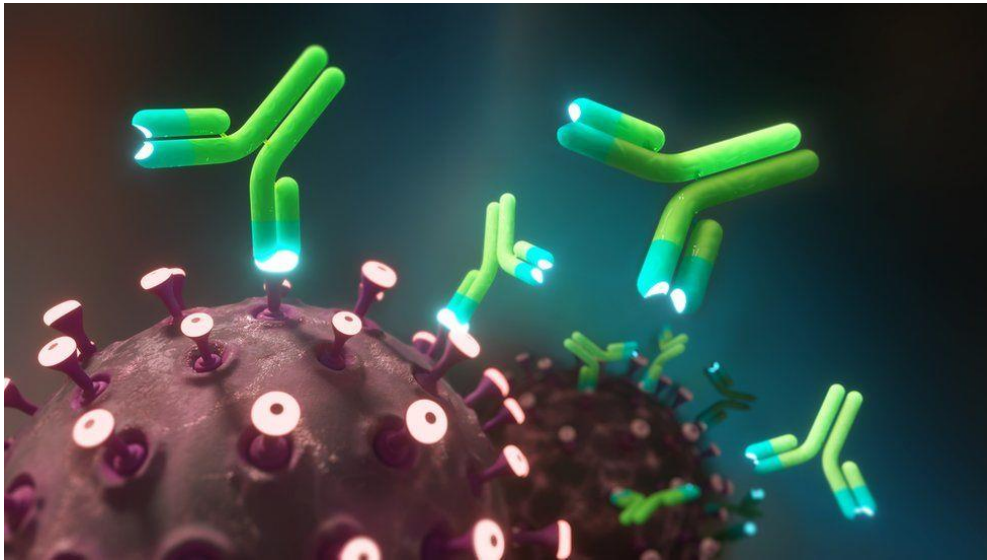
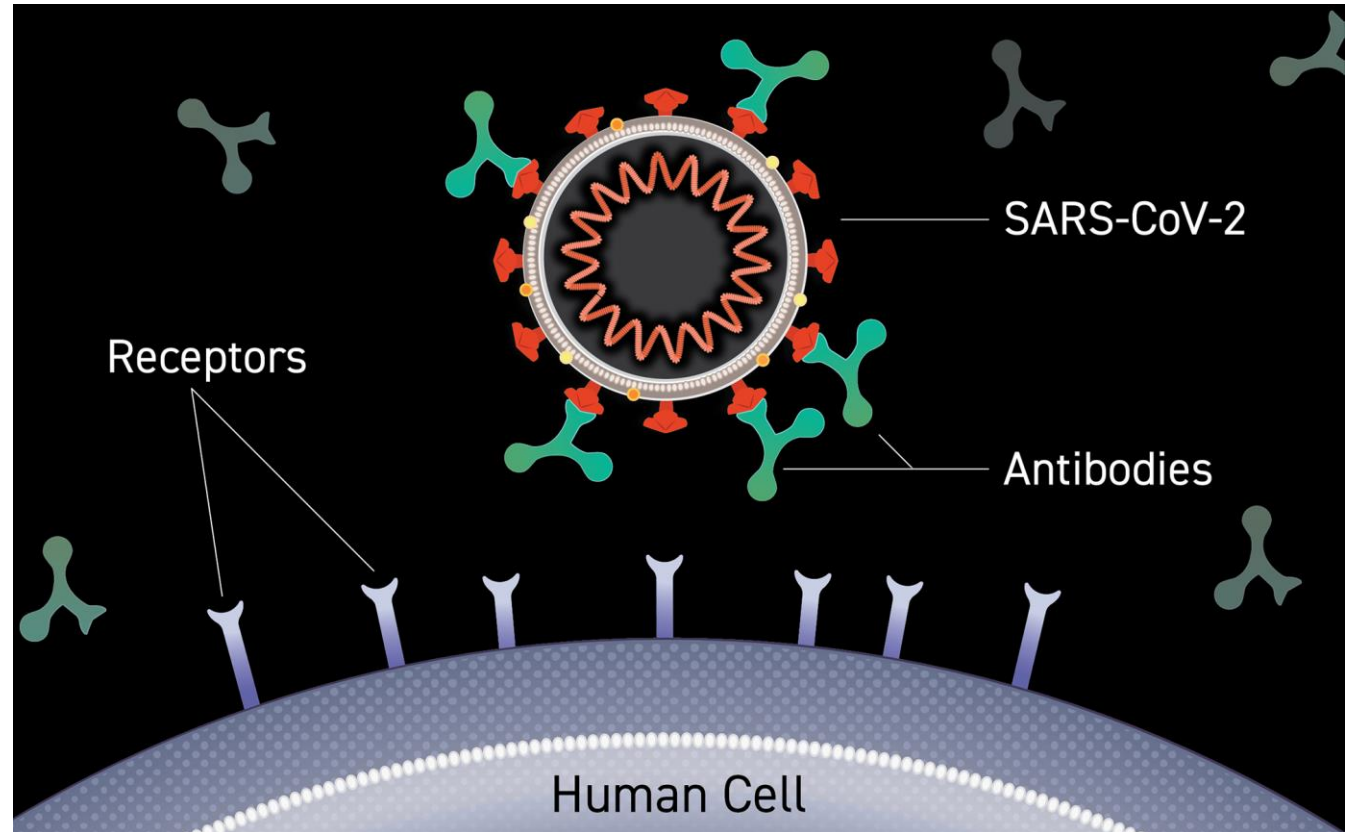
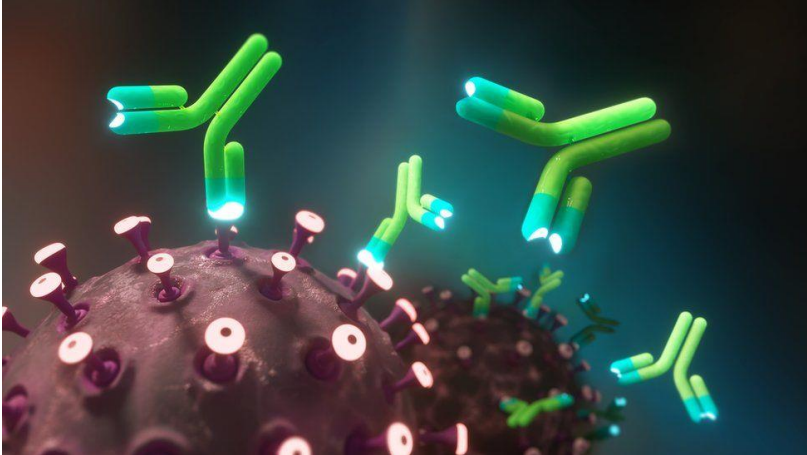


FIGURE 7.2

Cell surface receptors recognize only specific molecules. Signal molecules will bind only to those cells displaying receptor proteins with a shape into which they can fit snugly.

RECEPTORS

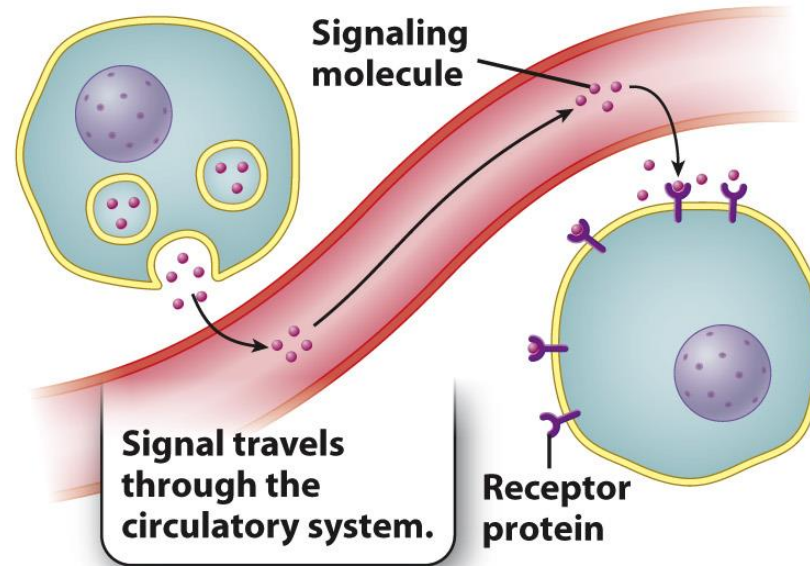
- 0.01% of the total mass of protein in a cell
- Search through:
 1. Gene analysis
 2. Monoclonal antibodies



CELLS TALK IN CODES

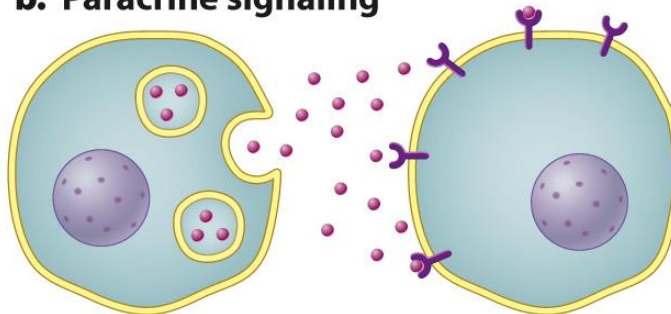
Hormones

a. Endocrine signaling

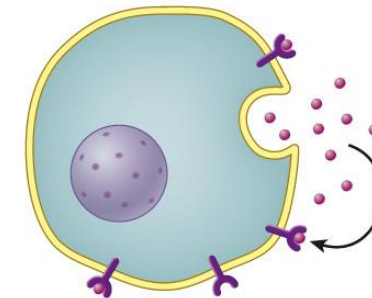


Growth factors/
Neurotransmitters

b. Paracrine signaling

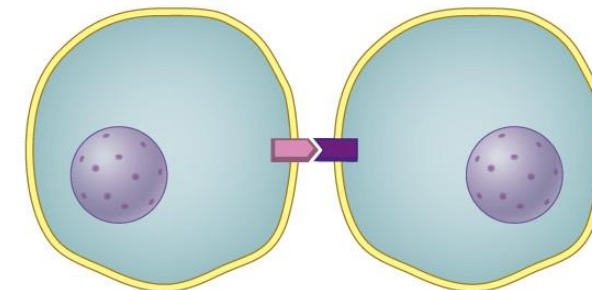


c. Autocrine signaling



Cancer

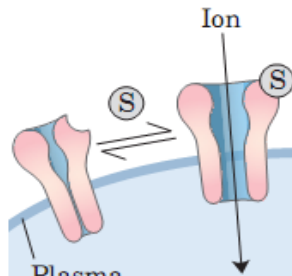
d. Contact-dependent signaling



Immune cells
(T-cell)

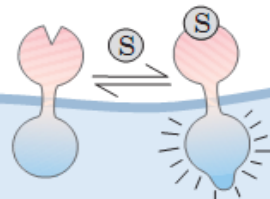
CELL SIGNALLING

Gated ion channel
Opens or closes in response to concentration of signal ligand (S) or membrane potential.

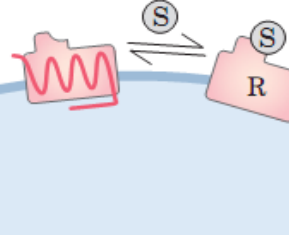


Plasma membrane

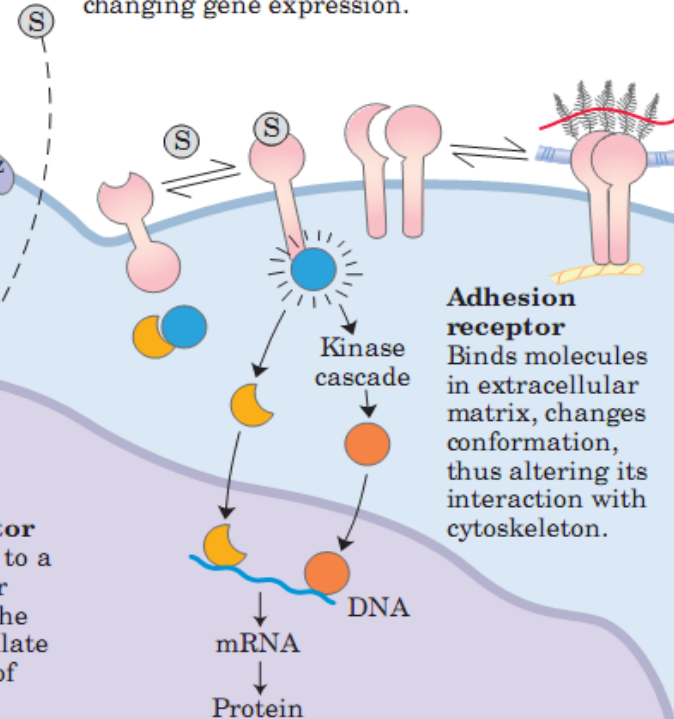
Receptor enzyme
Ligand binding to extracellular domain stimulates enzyme activity in intracellular domain.



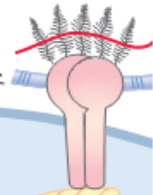
Serpentine receptor
External ligand binding to receptor (R) activates an intracellular GTP-binding protein (G), which regulates an enzyme (Enz) that generates an intracellular second messenger, X.



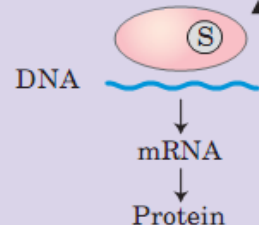
Receptor with no intrinsic enzyme activity
Interacts with cytosolic protein kinase, which activates a gene-regulating protein (directly or through a cascade of protein kinases), changing gene expression.



Adhesion receptor
Binds molecules in extracellular matrix, changes conformation, thus altering its interaction with cytoskeleton.

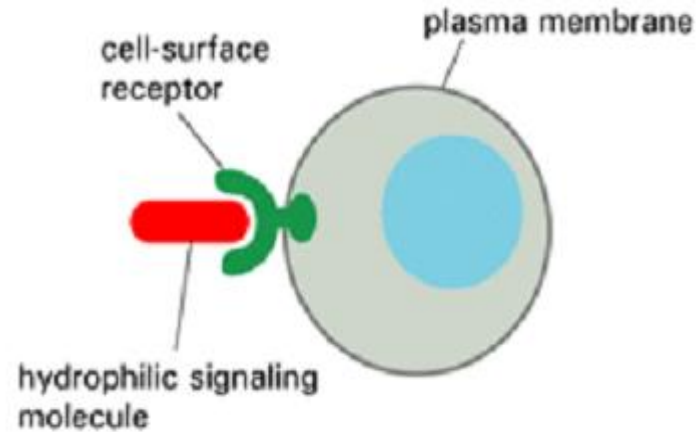


Steroid receptor
Steroid binding to a nuclear receptor protein allows the receptor to regulate the expression of specific genes.



Nuclear envelope

CELL-SURFACE RECEPTORS



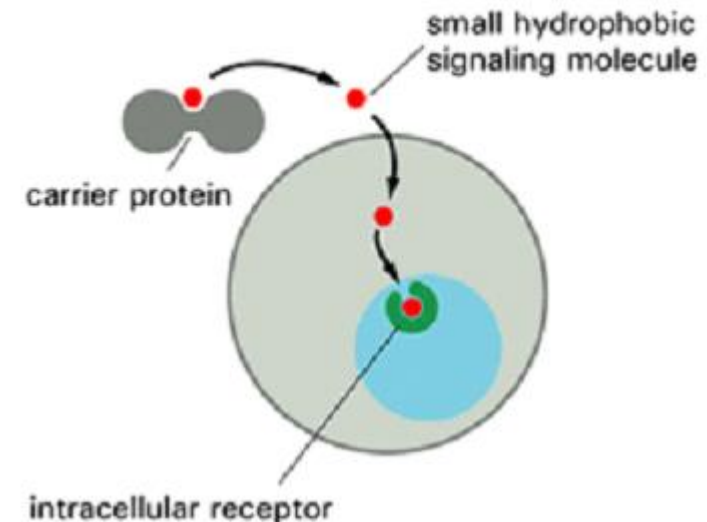
Extra cellular Hormone

- a) Hydrophilic- Glucagon, Insulin, Epinephrine and Norepinephrine
- b) Lipophilic-
 - 1) Membrane Receptor-Prostaglandins
 - 2) Nuclear Receptor- sex hormones, thyroxine, Vitamin D, Retinoic Acid

Intra cellular Hormone

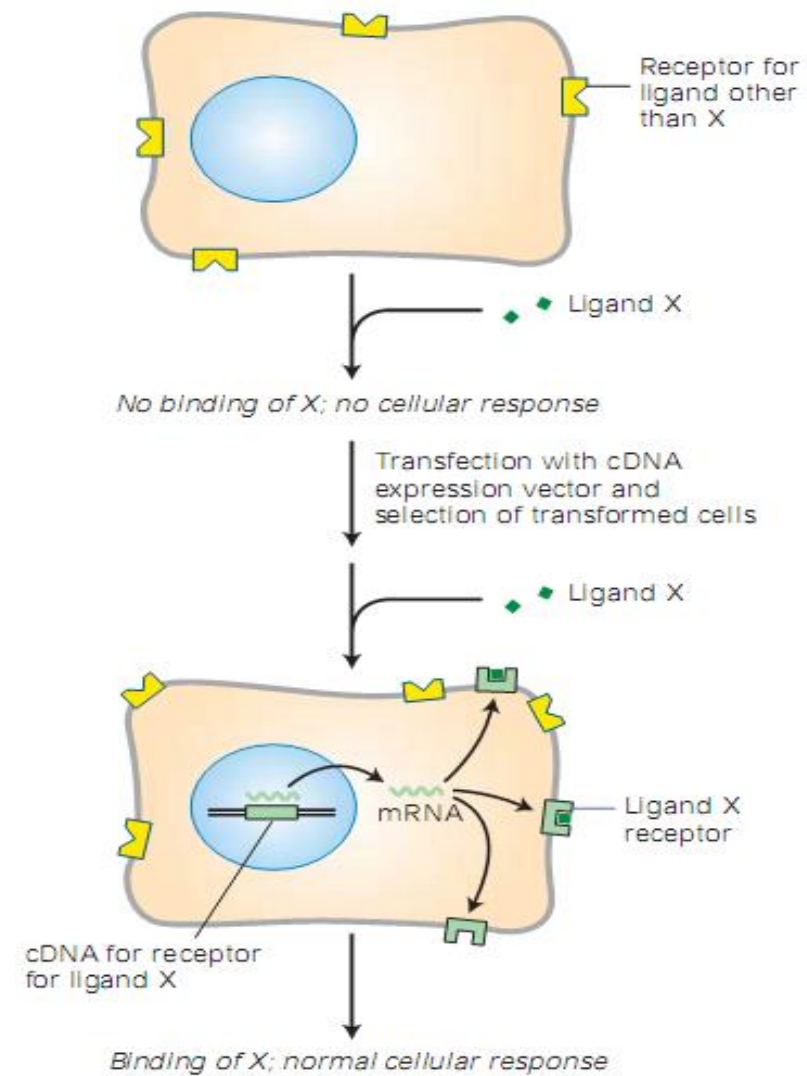
- a) Proteinaceous- Kinase, Phosphatase, GTPase switch protein (ras, rab)
- b) Non-proteinaceous (sec. messenger)- cAMP, IP3, DAG, Ca²⁺, Phosphoinoside

INTRACELLULAR RECEPTORS



CELL RECEIVING

- Modulation of the gene activity



RECEPTOR COMPLEX

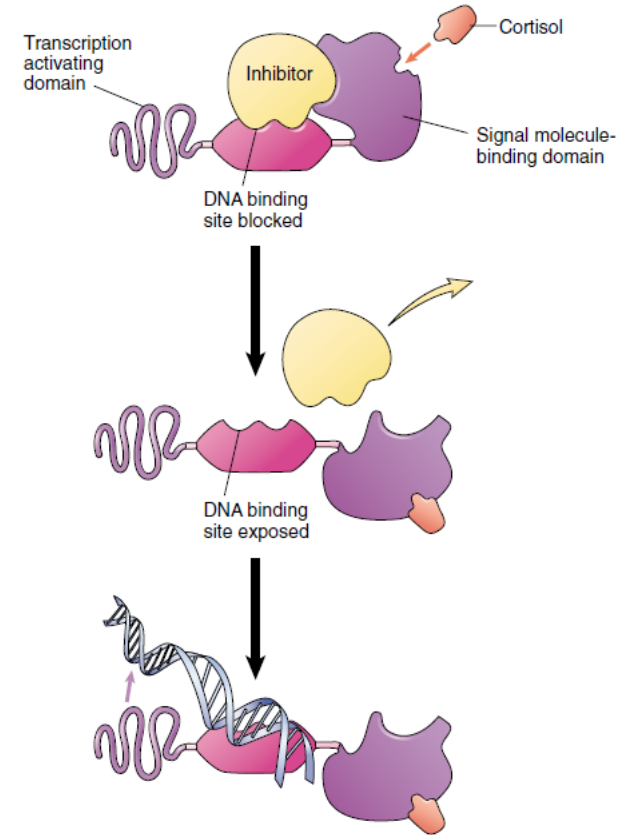
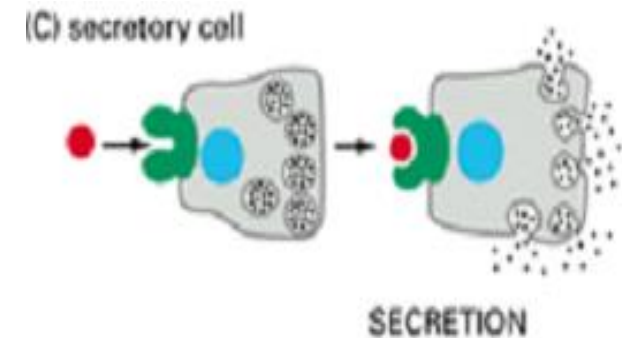
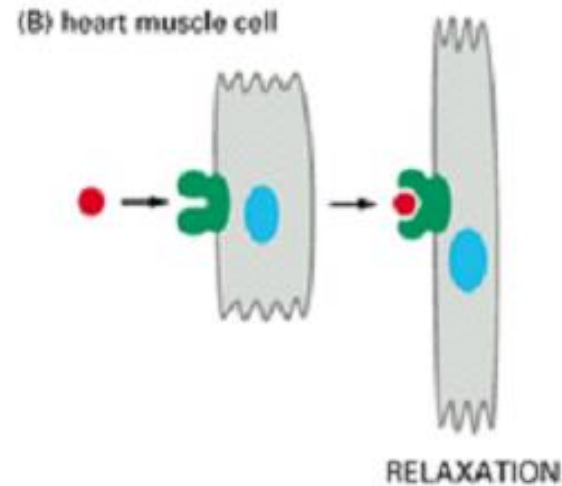
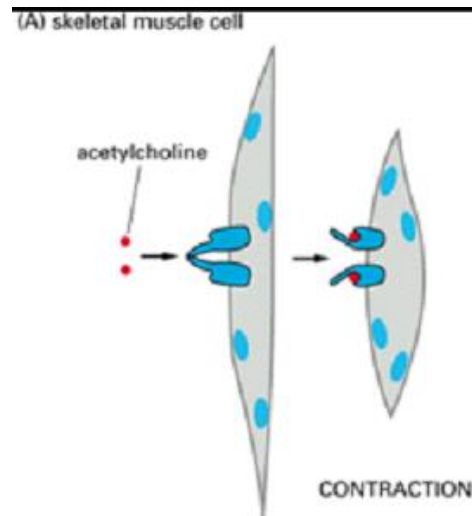


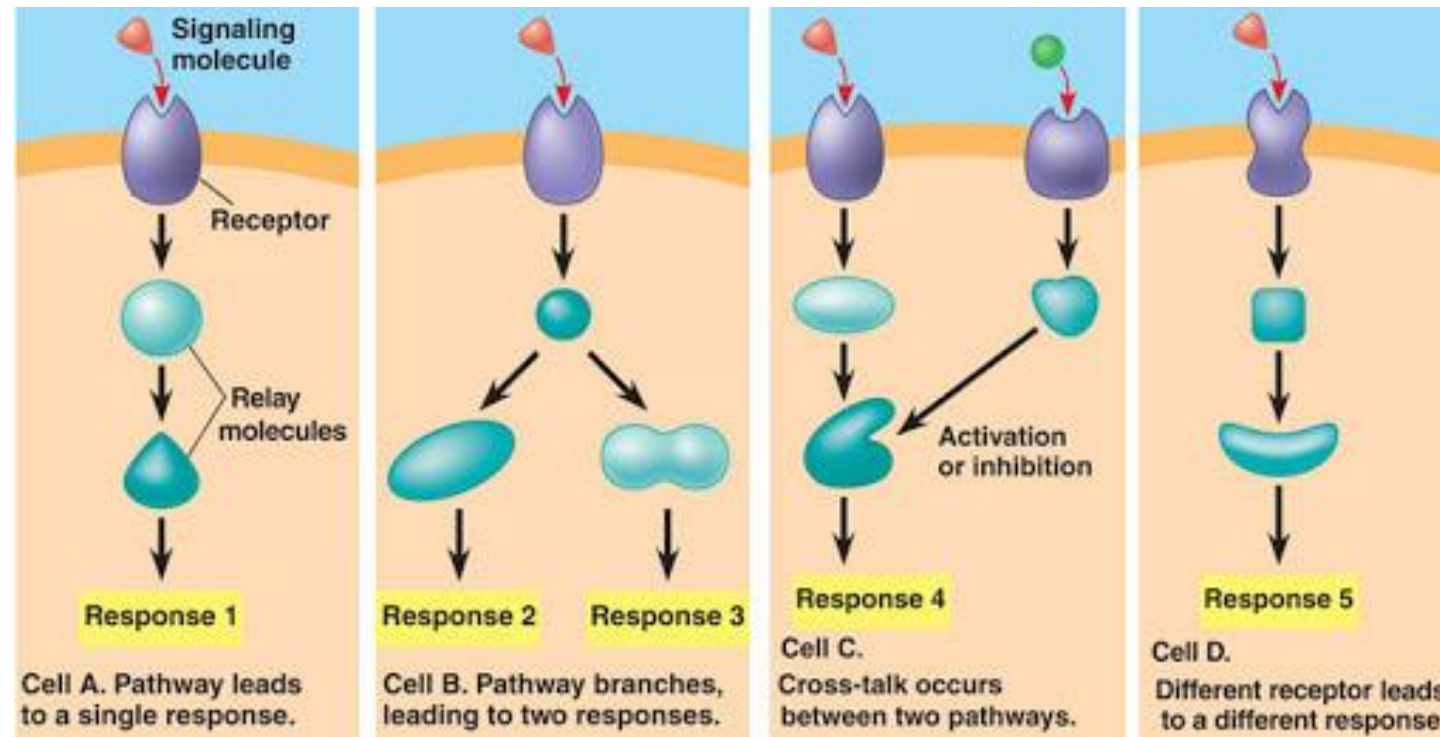
FIGURE 7.5

How intracellular receptors regulate gene transcription. In this model, the binding of the steroid hormone cortisol to a DNA regulatory protein causes it to alter its shape. The inhibitor is released, exposing the DNA binding site of the regulatory protein. The DNA binds to the site, positioning a specific nucleotide sequence over the transcription activating domain of the receptor and initiating transcription.

ACETYLCHOLINE AS THE SIGNALING MOLECULE



PERMUTATION-COMBINATIONS



Group I

CELL-CELL JUNCTIONS

Gap Junctions:

- Tube formed between cells
- Facilitates exchange
- Electrochemical signals in cardiac cells and neuron

Tight Junctions

- Only cells sticking tightly
- Fluid passage
- Intestine and Kidneys

Plasmodesmata

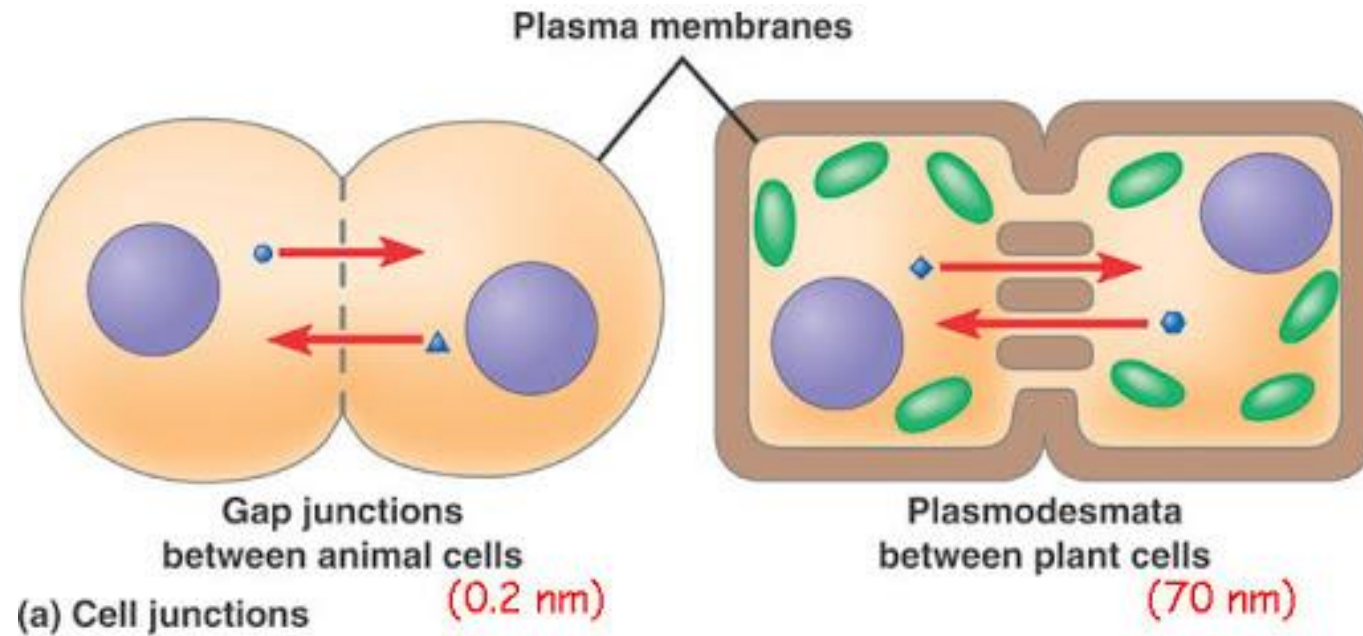
- Cell junction in plants

TIGHT JUNCTION VERSUS GAP JUNCTION

TIGHT JUNCTION	GAP JUNCTION
A specialized connection of two adjacent animal cell membranes, such that, space usually lying between them is absent	A linkage of two adjacent cells consisting of a system of channels extending across a gap from one cell to the other, allowing the passage
Also known as occluding junctions and zonulae occludentes	Also known as nexus and macula communicans
Occur in the epithelia of vertebrates	Occur in all types of tissues, except in fully-developed skeletal muscles and mobile cells types
Contain plasma membranes, which are very tightly pressed against each other due to bound proteins	Consist of cytoplasmic channels from one to the other cytoplasm, surrounding with membrane proteins
Contain proteins called claudins	Contain proteins called connexins
Regulate the movement of water and solutes between epithelial layers	Allows the direct chemical communication between adjacent cytoplasm
Prevent the leakage of extracellular fluid across the epithelial cell layer	Allow the movement of ions, sugars, amino acids, and other small molecules between cells

Visit www.PEDIAA.com

CELL-CELL JUNCTIONS



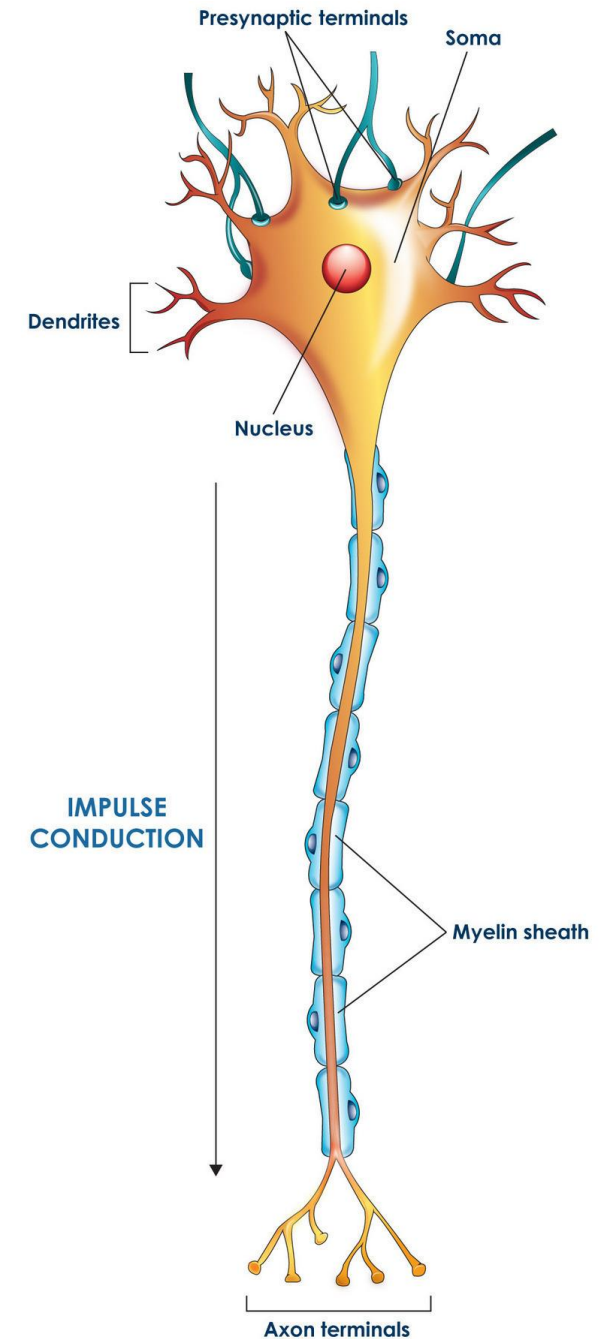
COMMUNICATION LOSS LEADS TO:

Multiple Sclerosis

Myelin sheath that protects nerve cells disappears

Brain and spinal cord

Signal do not pass



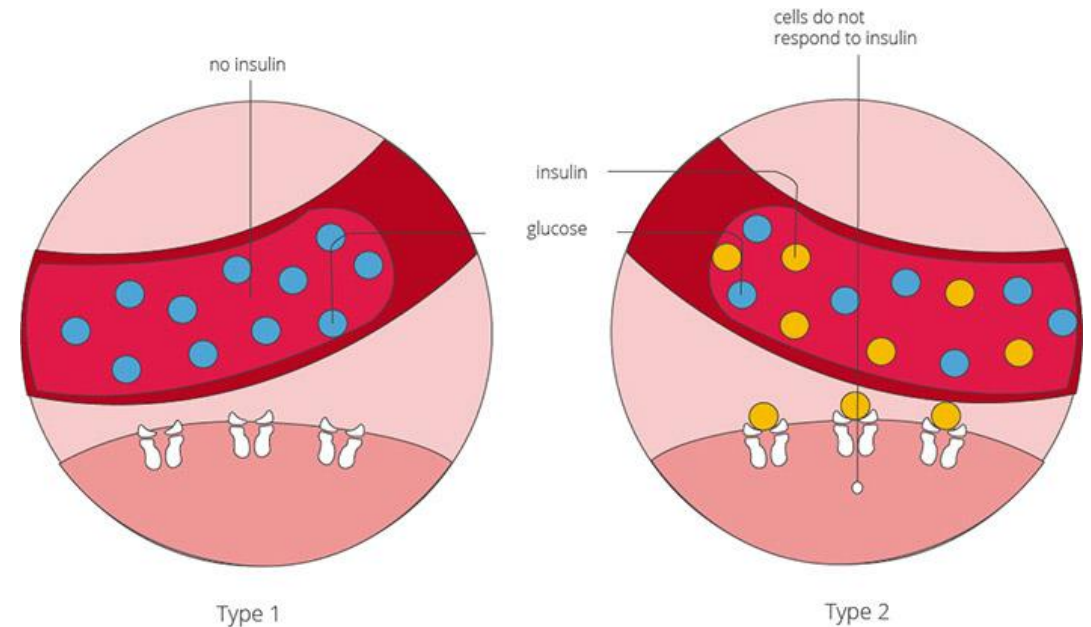
COMMUNICATION LOSS LEADS TO:

Diabetes

Target cell receptor not responding to Insulin signal

Diabetes 1- insulin signal is unable to be produced

Diabetes 2- cells have lost the ability to respond to the signals, resulting in abnormally high and dangerous sugar levels in the blood



COMMUNICATION LOSS LEADS TO:

Brain Stroke

- Abnormally high amount of glutamate secreted by dying brain cells
- Kills healthy brain cells (excitotoxicity)
- Extensive brain damage

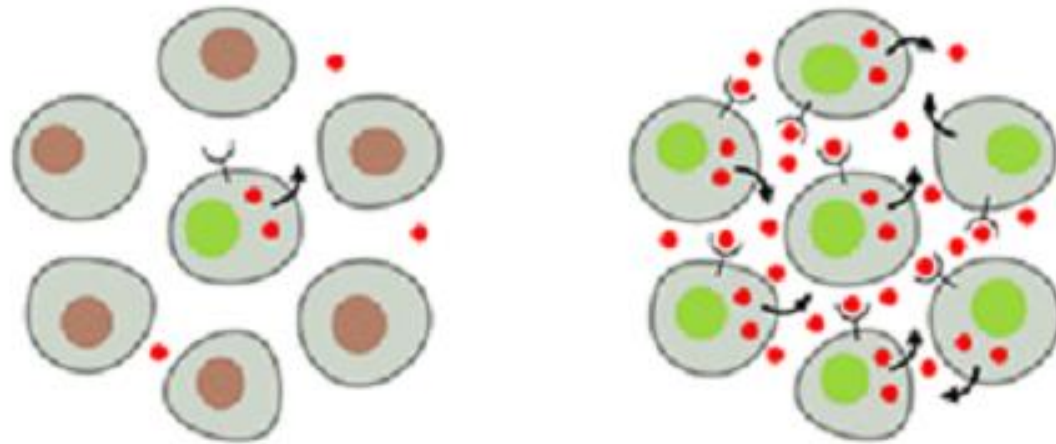


COMMUNICATION LOSS LEADS TO:

Cancer

Breakdown of multiple signaling pathways

Uncontrolled proliferation of cells- cancer



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