

**Big Idea 3: Living
systems store, retrieve,
transmit and respond
to information essential
to life processes.**

Enduring understanding 3.D:
Cells communicate by
generating, transmitting and
receiving chemical signals.

Essential knowledge 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.

a. Cells communicate by cell-to-cell contact.

To foster student understanding of this concept, instructors can choose an illustrative example such as:

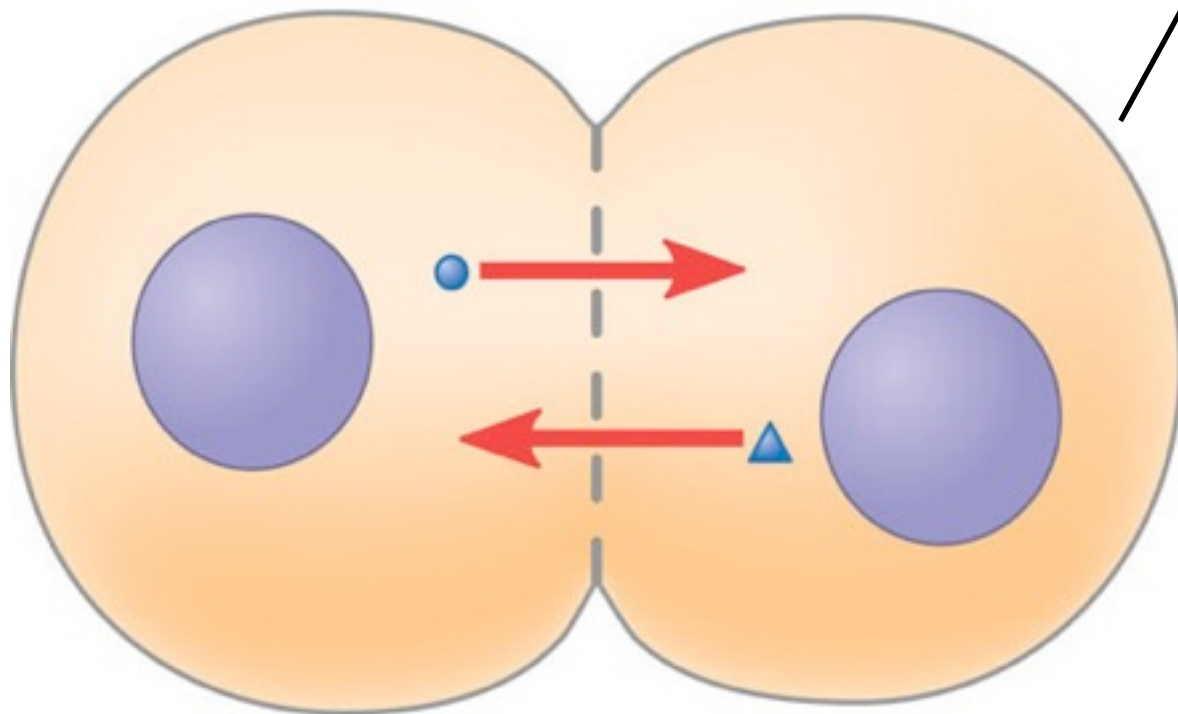
- Immune cells interact by cell-cell contact, antigen-presenting cells, helper T-cells and killer T-cells. [See also 2.D.4]
- Plasmodesmata between plant cells that allow material to be transported from cell to cell.

Local Signaling (I)

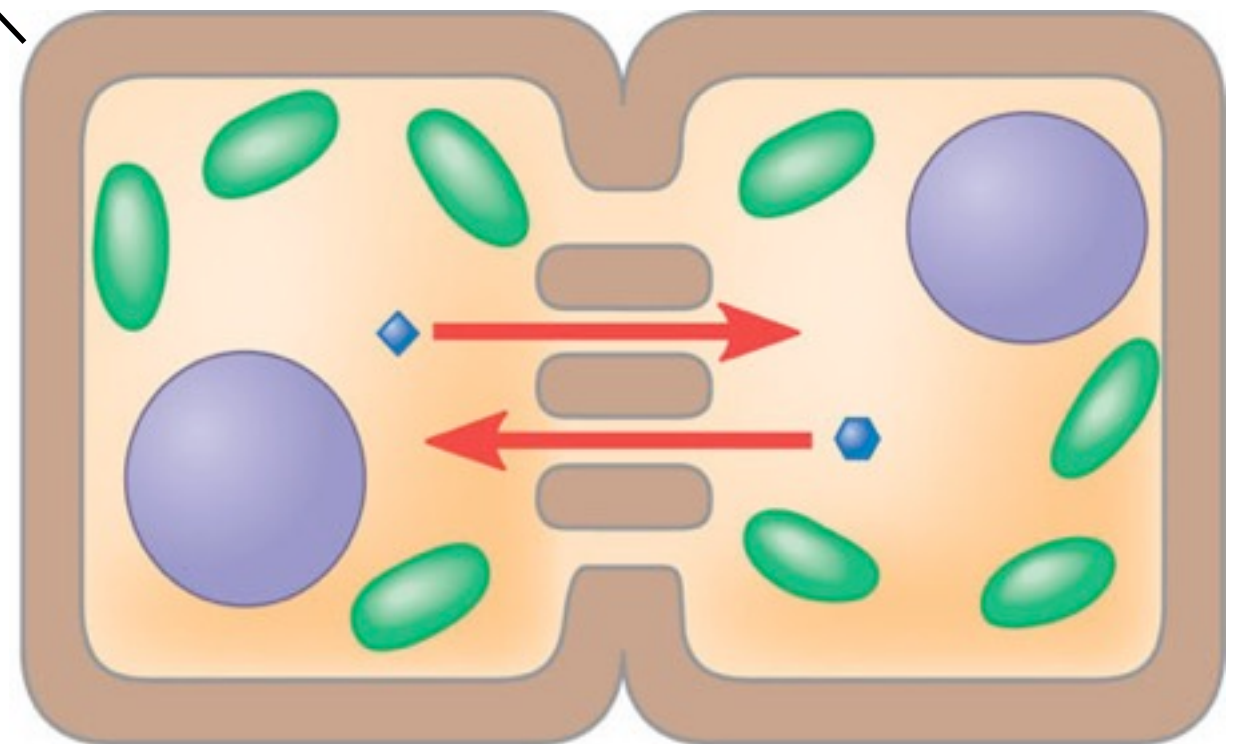
Cell junctions

Both animals and plants have cell junctions that allow molecules

Plasma membranes



**Gap junctions
between animal cells**

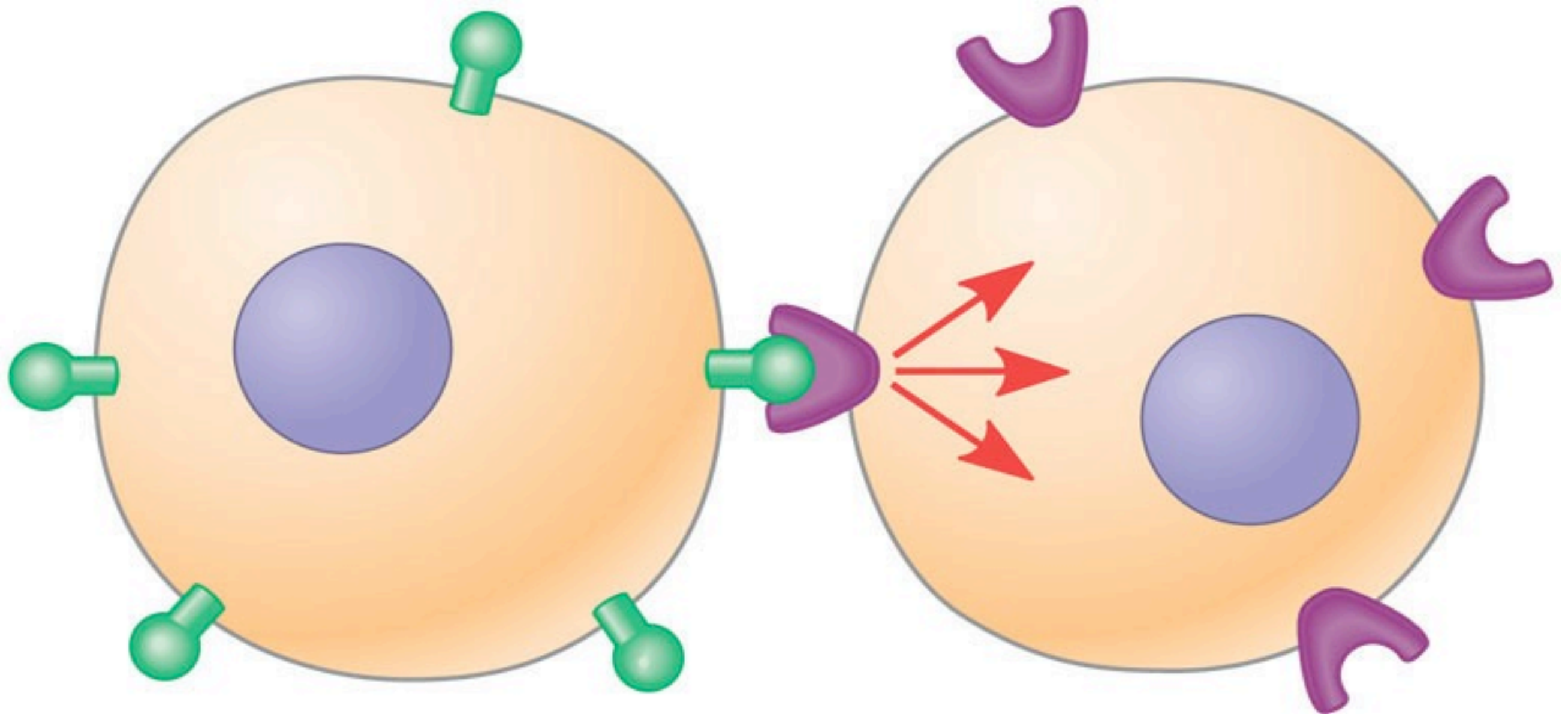


**Plasmodesmata
between plant cells**

Local Signaling (2)

Cell-Cell recognition

Two cells in an animal may communicate by interaction between molecules protruding from

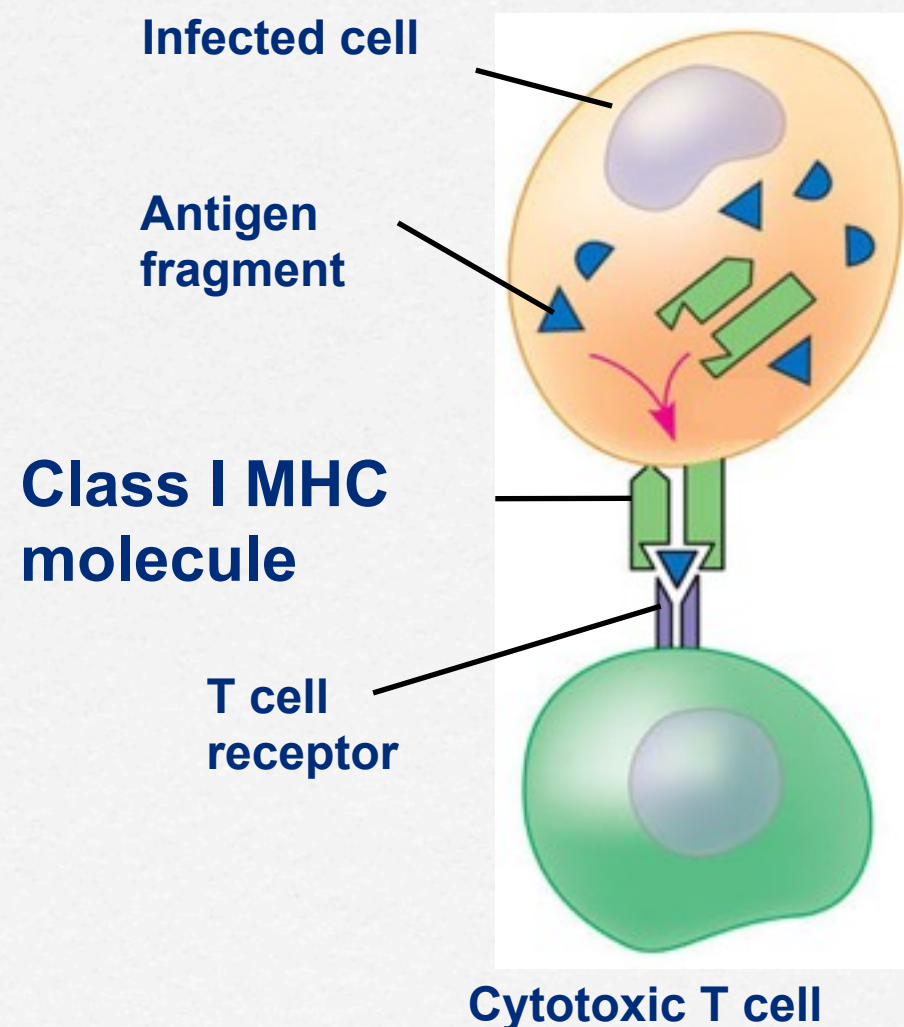


Where have we seen this before?

**Answer: Cell Recognition
in immune system**

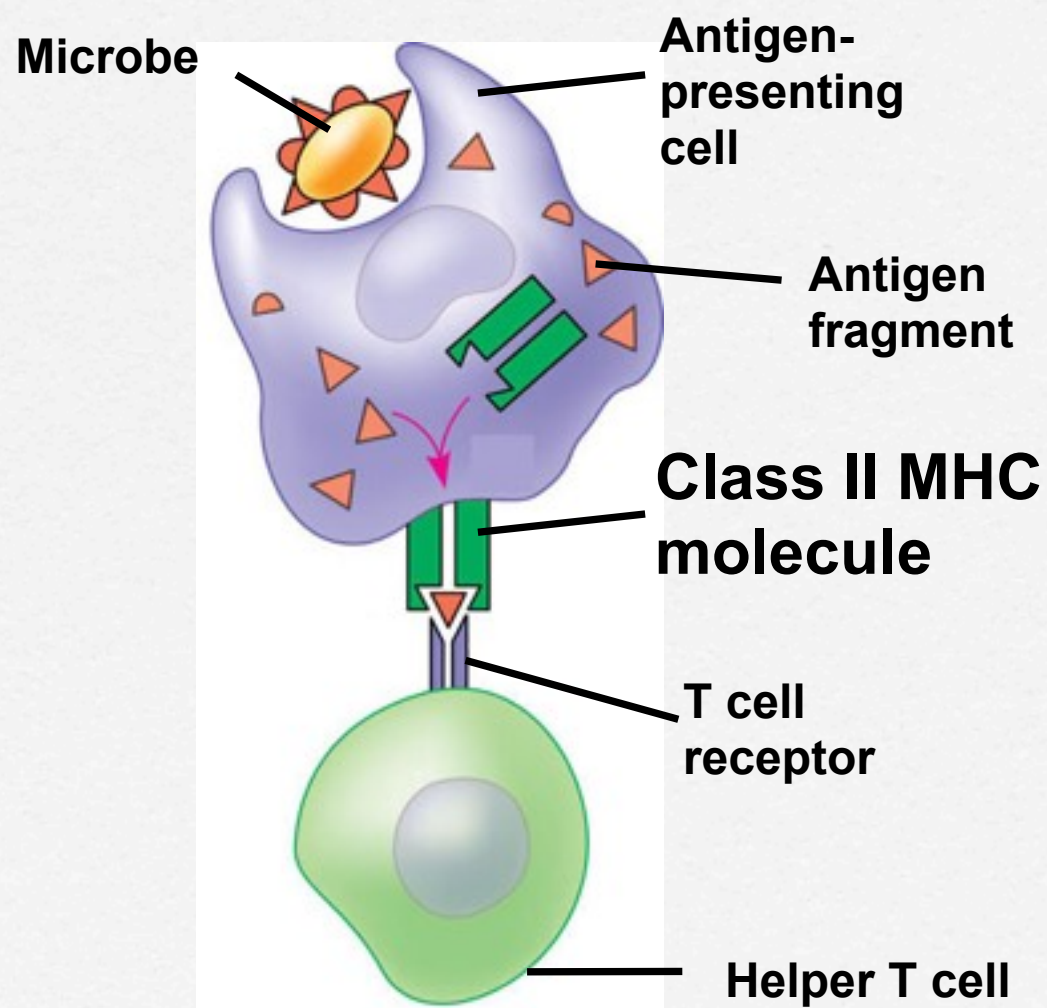
Antigen: Presentation & Recognition

- Class I MHC molecules, found on almost all nucleated cells of the body.
- Display peptide antigens to cytotoxic T cells

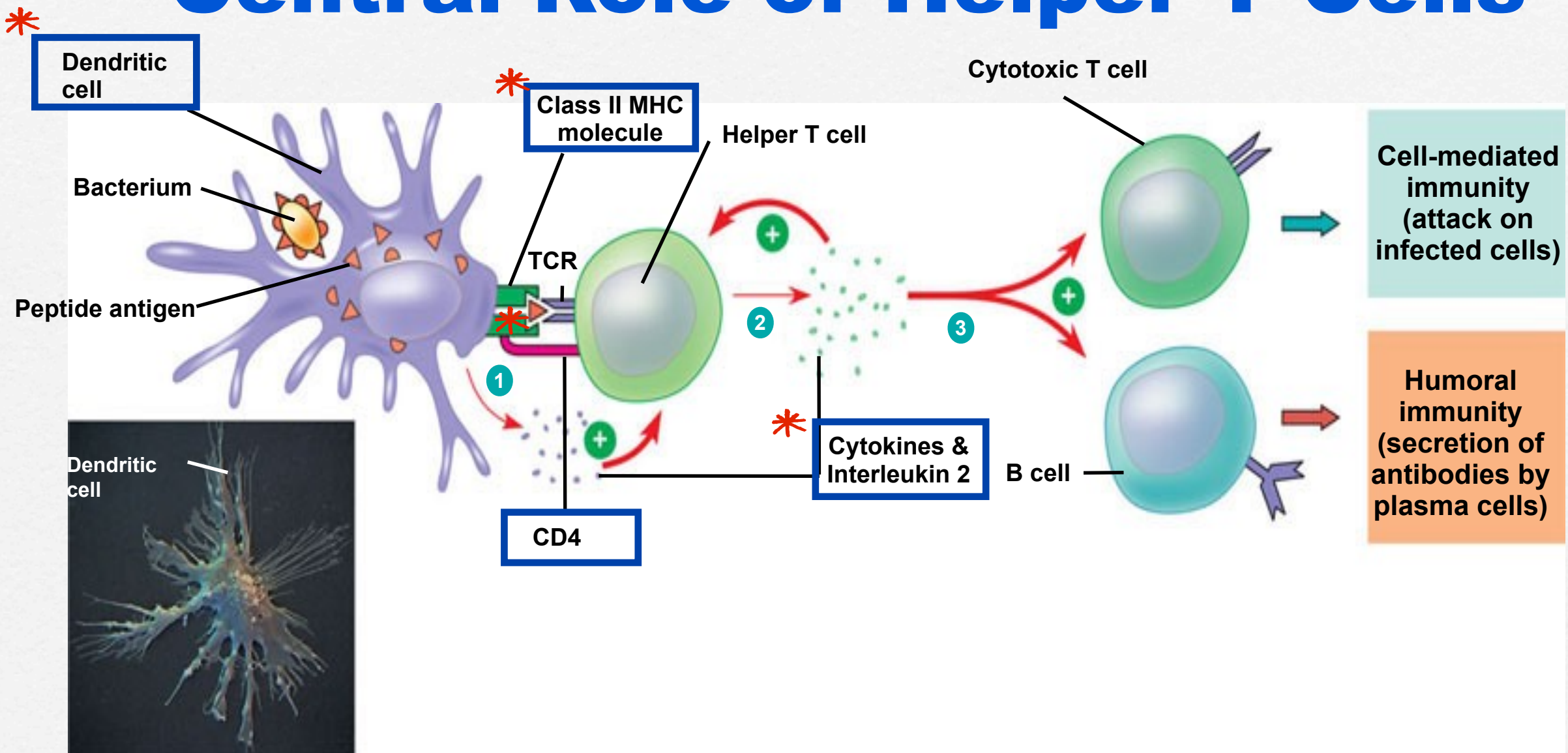


Antigen: Presentation & Recognition

- Class II MHC molecules, found on dendritic cells, macrophages and B cells.
- Display peptide antigens to helper T cells



Central Role of Helper T Cells



If dendritic cell presents antigen it is likely a primary immune response

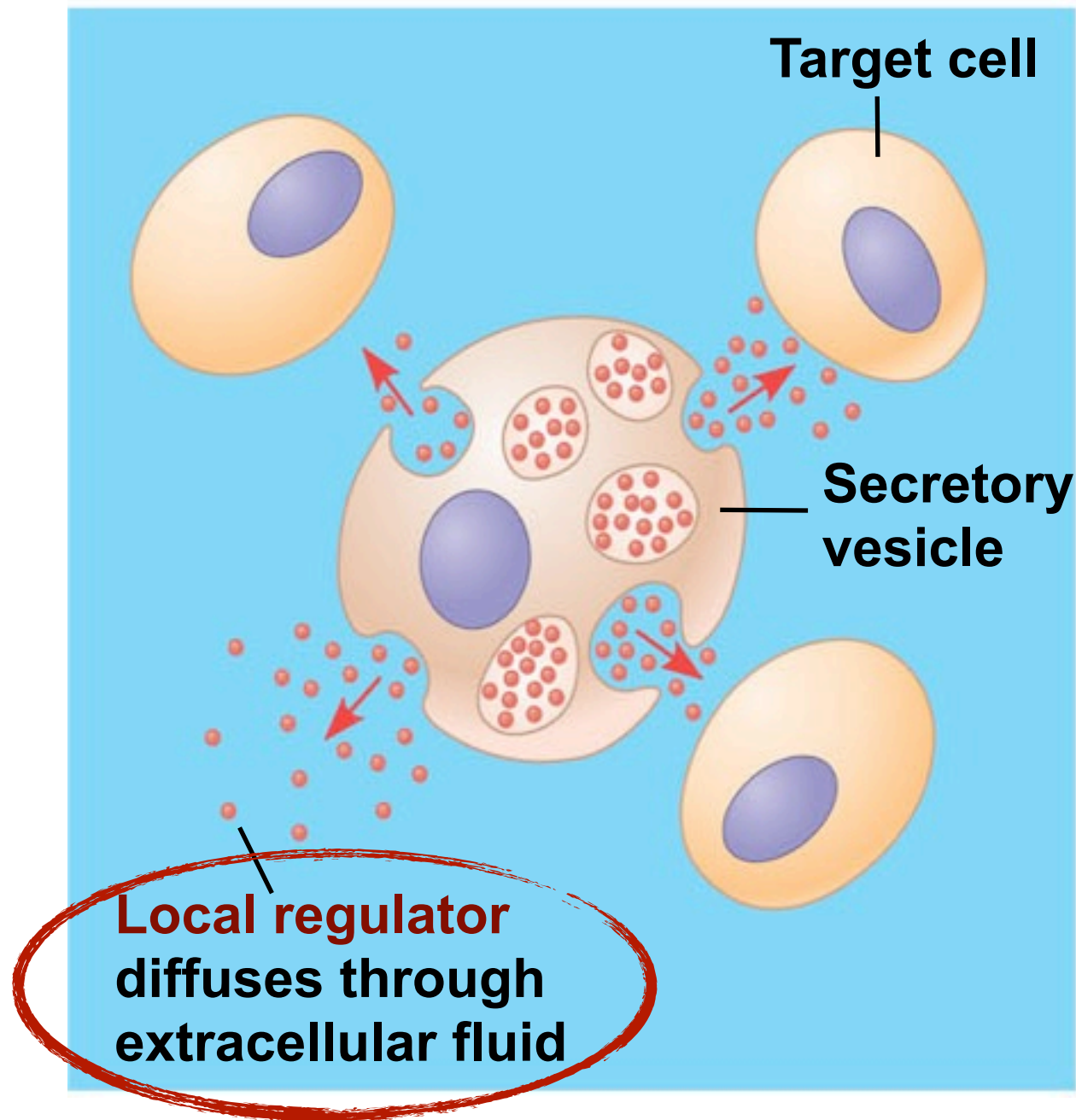
Essential knowledge 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.

b. Cells communicate over short distances by using local regulators that target cells in the vicinity of the emitting cell.

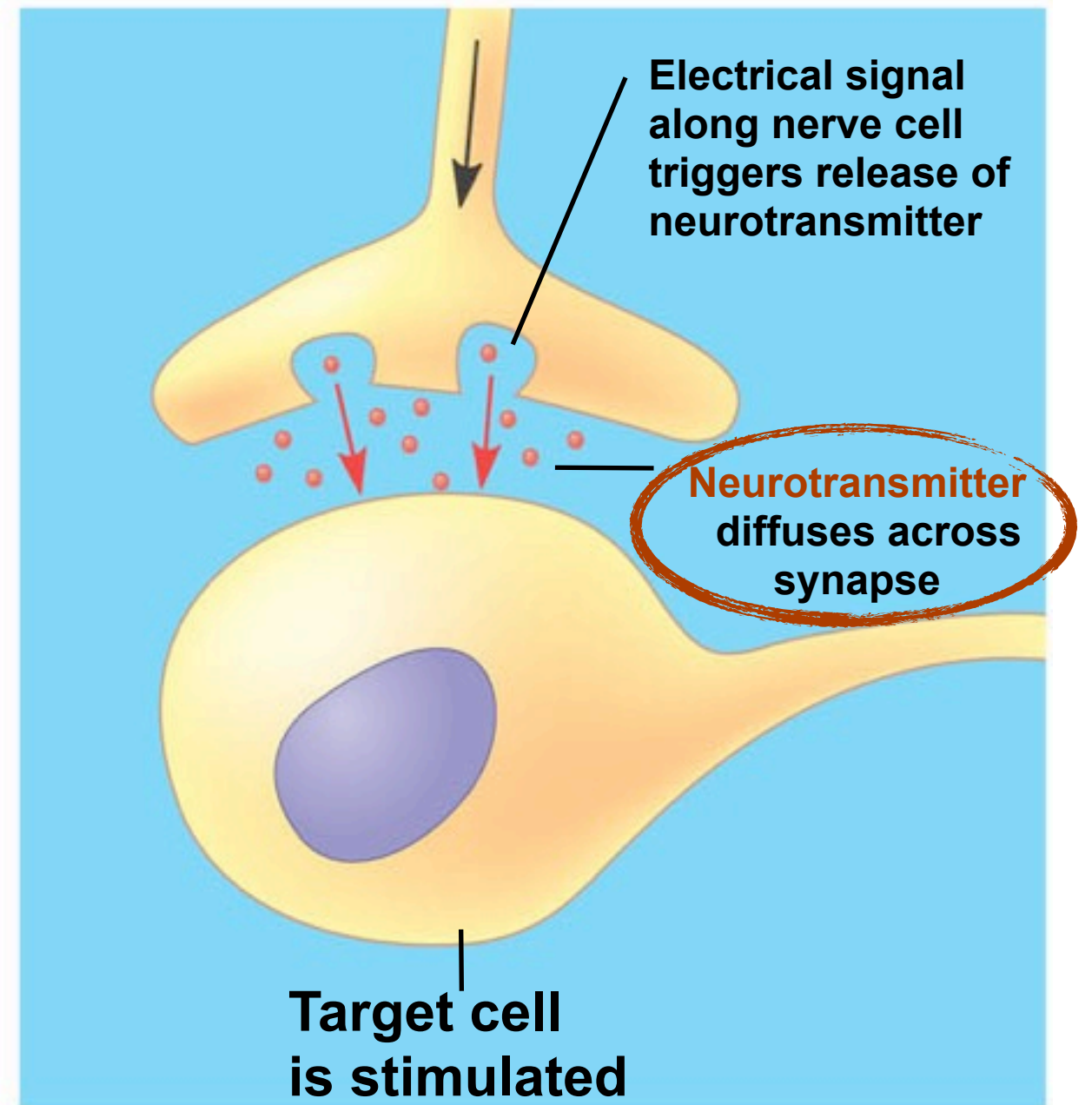
To foster student understanding of this concept, instructors can choose an illustrative example such as:

- Neurotransmitters
- Plant immune response
- Quorum sensing in bacteria
- Morphogens in embryonic development

Local Signaling (3)

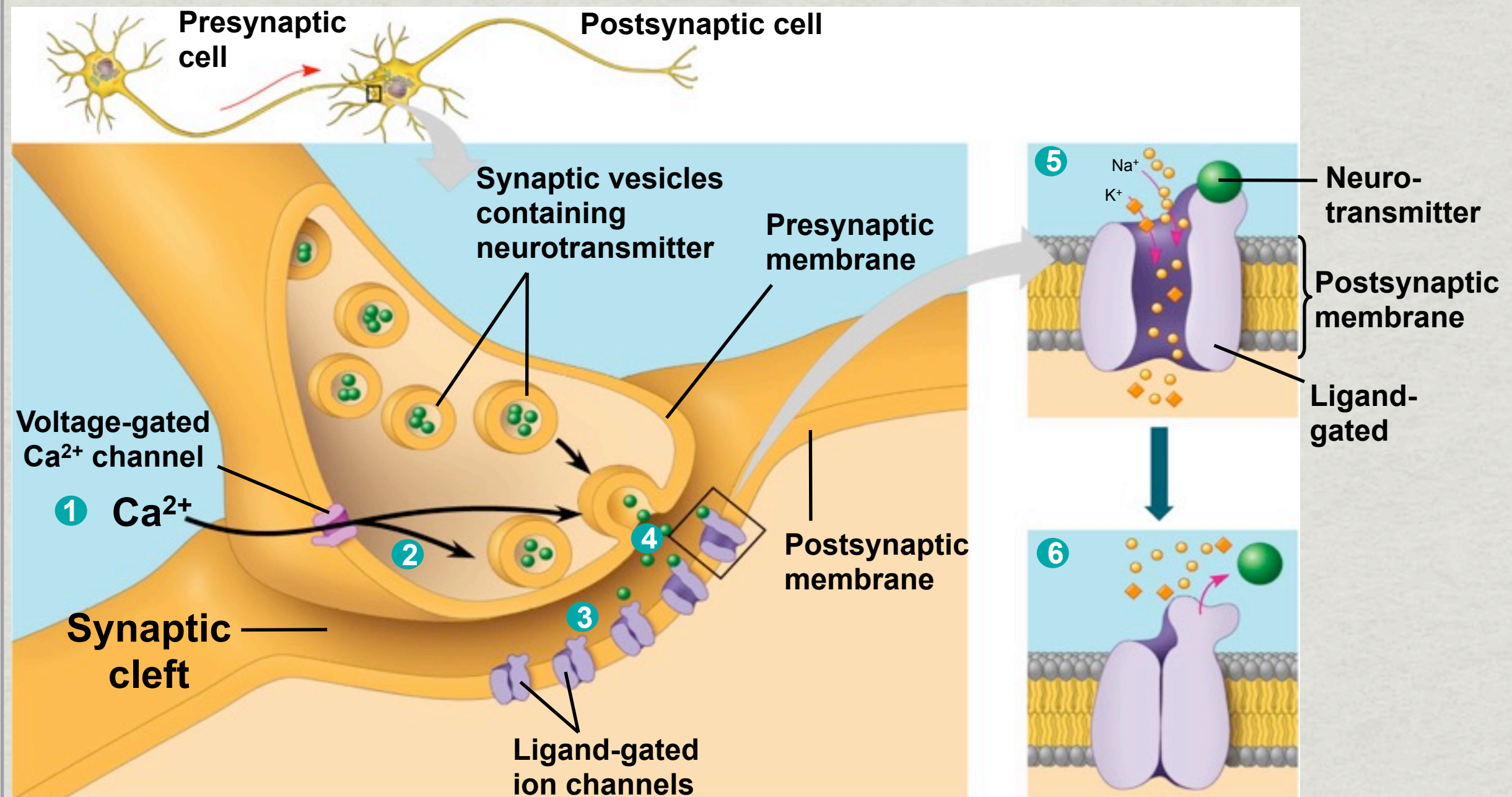


(a) Paracrine signaling. A secreting cell acts on nearby target cells by discharging molecules of a local regulator (a growth factor, for example) into the extracellular fluid.



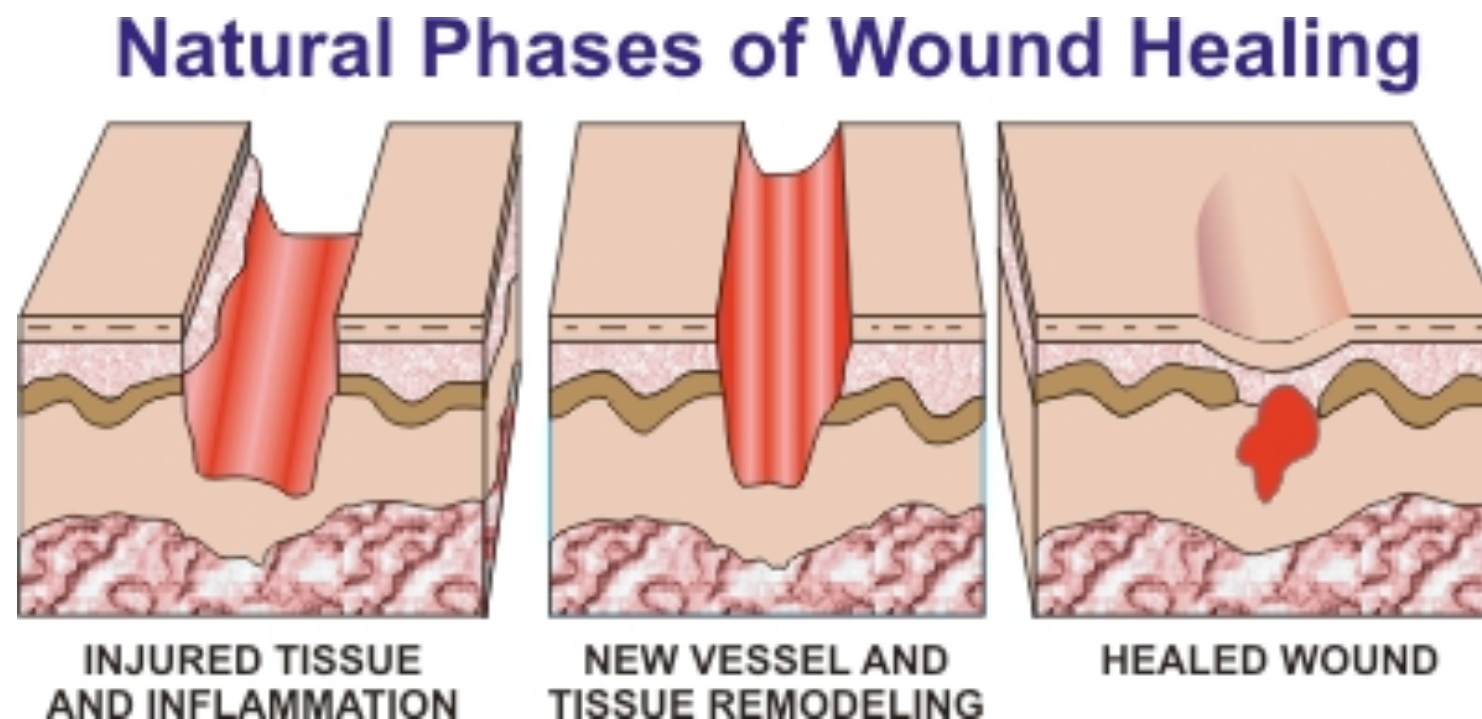
(b) Synaptic signaling. A nerve cell releases neurotransmitter molecules into a synapse, stimulating the target cell.

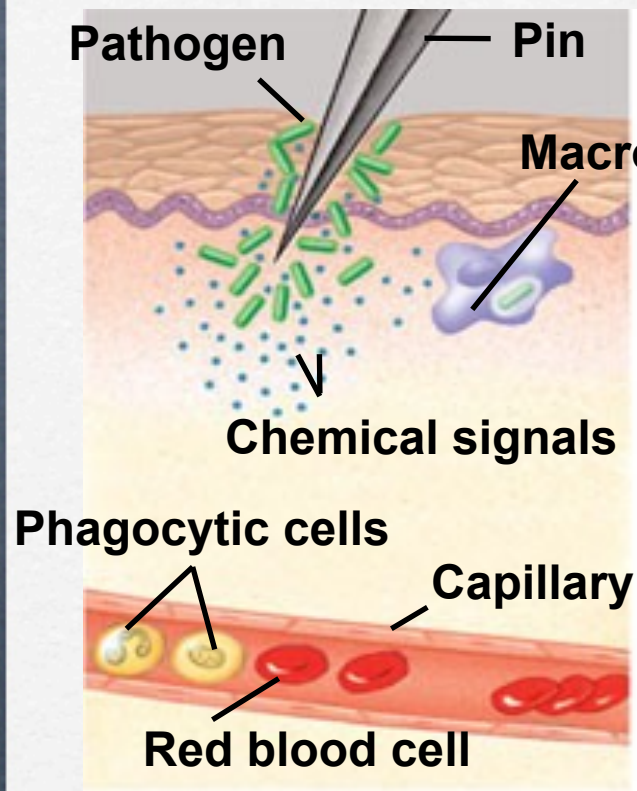
Neuron: FUNCTION (synaptic transmission)



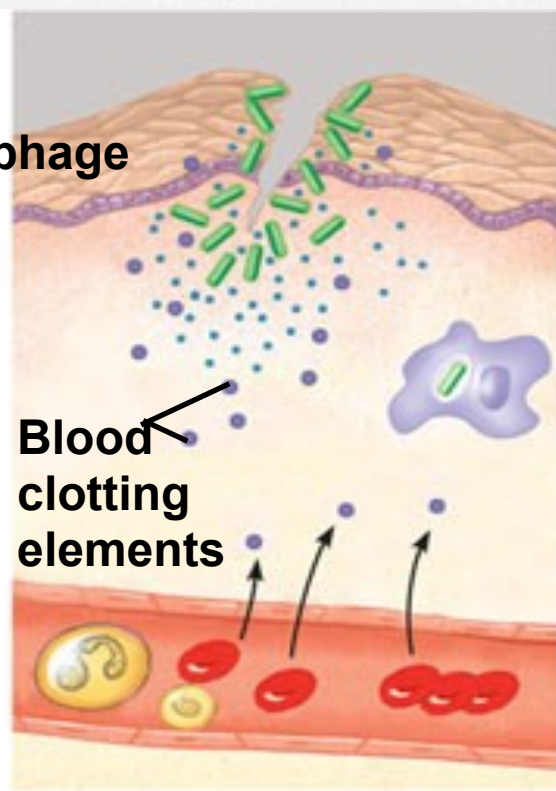
Local Regulators

- An example of a local regulator includes- **growth factors**.
- Imagine a cut or a wound, after the bleeding stops the body slowly begins to repair the area and after some time the wound heals and perhaps leaves a scar as a reminder .
- The damaged cells release **growth factors** to the undamaged cells in the vicinity, communicating the need the divide and thus repair the wound.

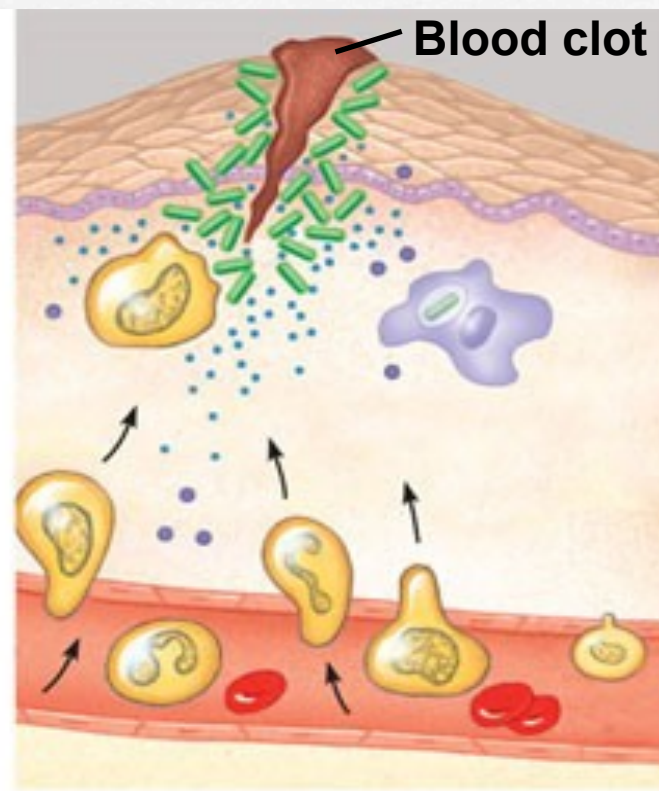




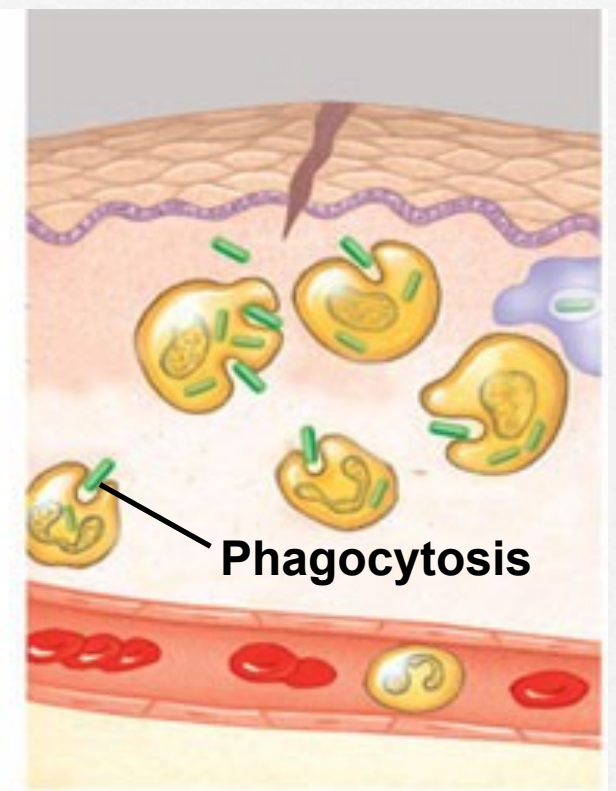
1.



2.



3.



4.

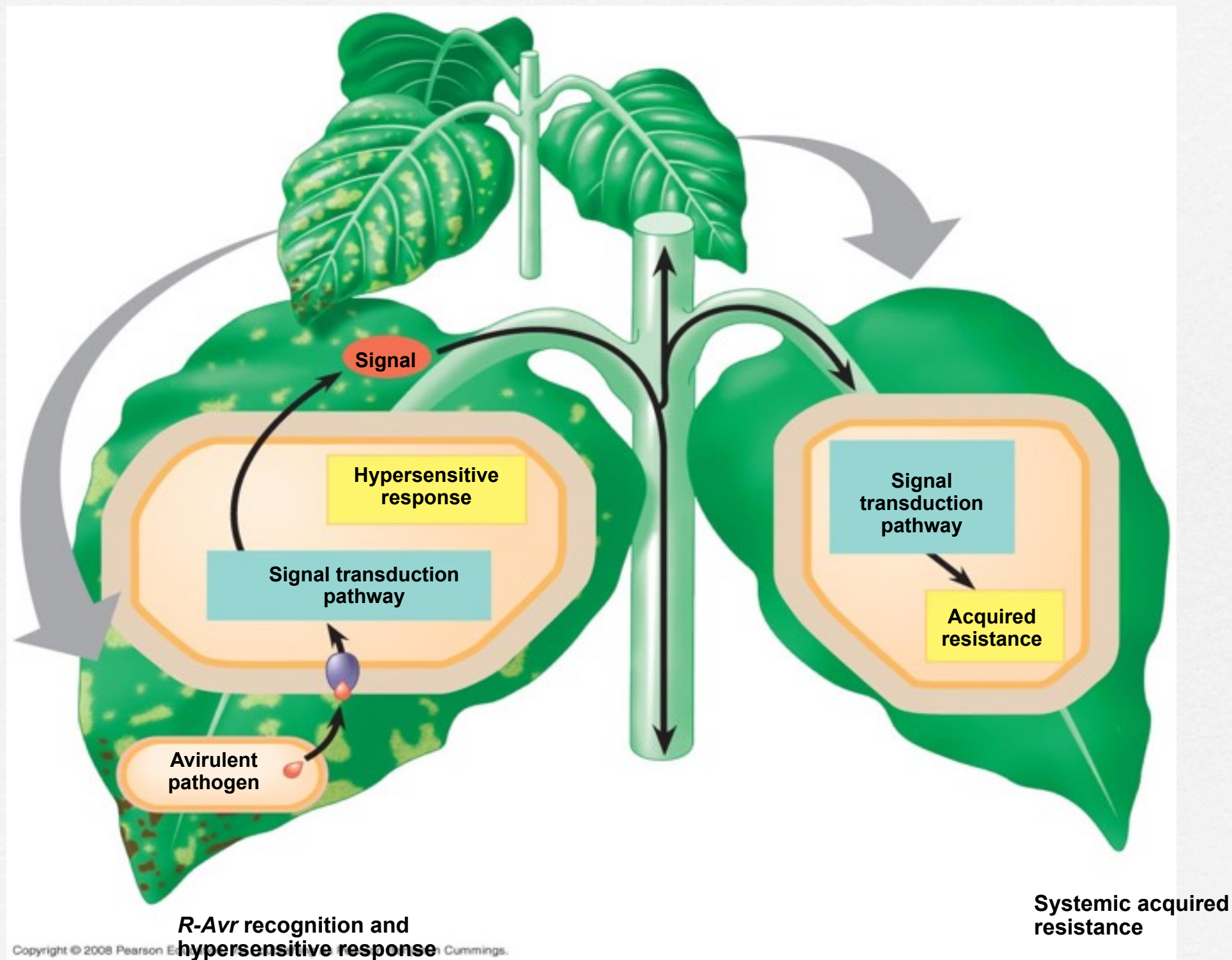
The Hypersensitive Response

- **Hypersensitive Response** is a defense response that causes tissue death near the infection site, thus restricting spread of pathogen.
- attack occurs, area is sealed off, infected cells destroy themselves
- ***phytoalexins*** that have fungicidal and bactericidal properties along with hydrolytic enzymes are released

Systemic Acquired Resistance

- **Systemic Acquired Resistance** arises from a plant wide expression on defense genes.
 - It is non-specific and provides protection that lasts for days
 - It is a chemical “alarm call” for the entire plant

Systemic Acquired Resistance



Essential knowledge 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.

c. Signals released by one cell type can travel long distances to target cells of another cell type.

Evidence of student learning is a demonstrated understanding of the following:

1. Endocrine signals are produced by endocrine cells that release signaling molecules, which are specific and can travel long distances through the blood to reach all parts of the body.

To foster student understanding of this concept, instructors can choose an illustrative example such as:

- Insulin, Human growth hormone, Thyroid hormones, Testosterone or Estrogen

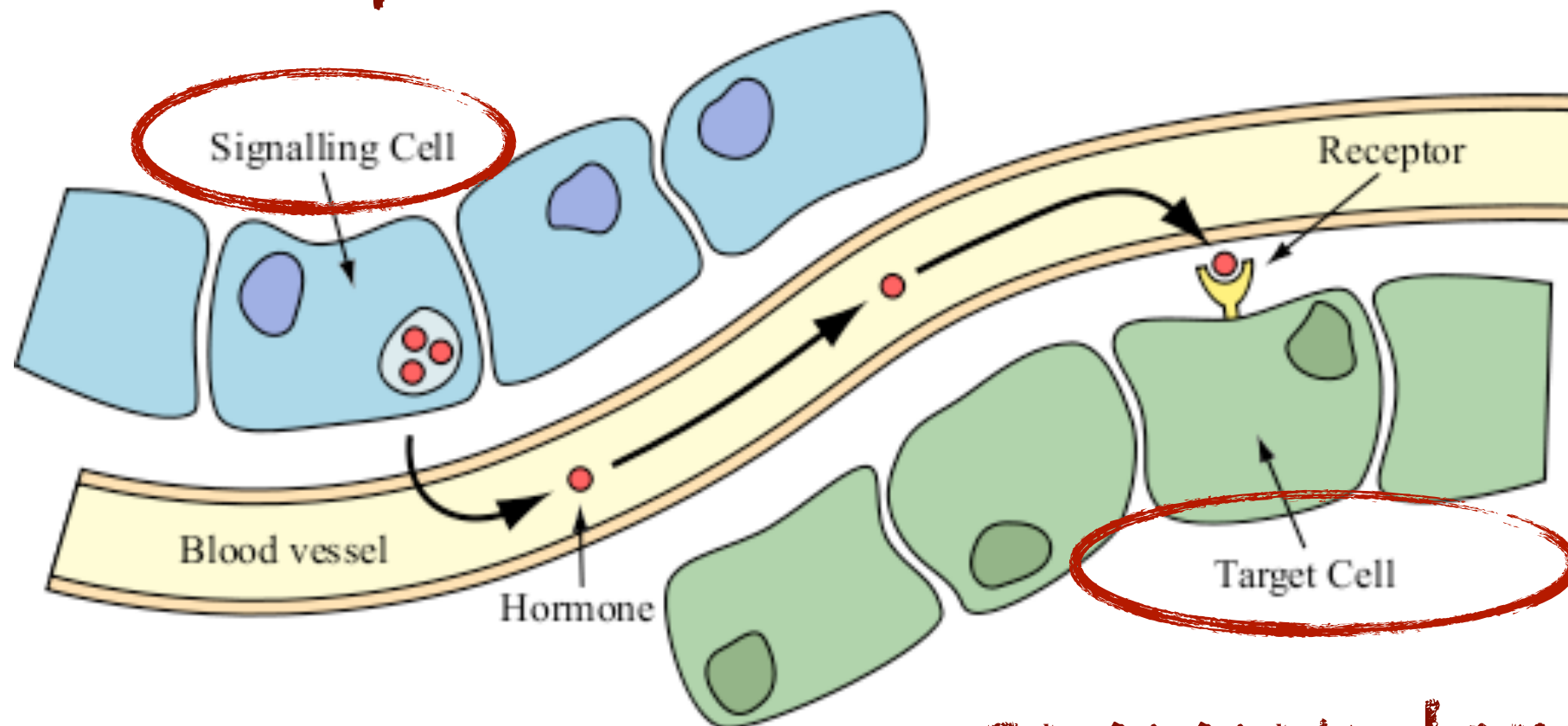
XX *No specific system, with the exception of the endocrine system, is required for teaching the concepts in 3.D.2 . Teachers are free to choose a system that best fosters student understanding. Study of the nervous and immune systems is required for concepts detailed in 3.E.2 and 2.D.4.*

Long Distance Signaling

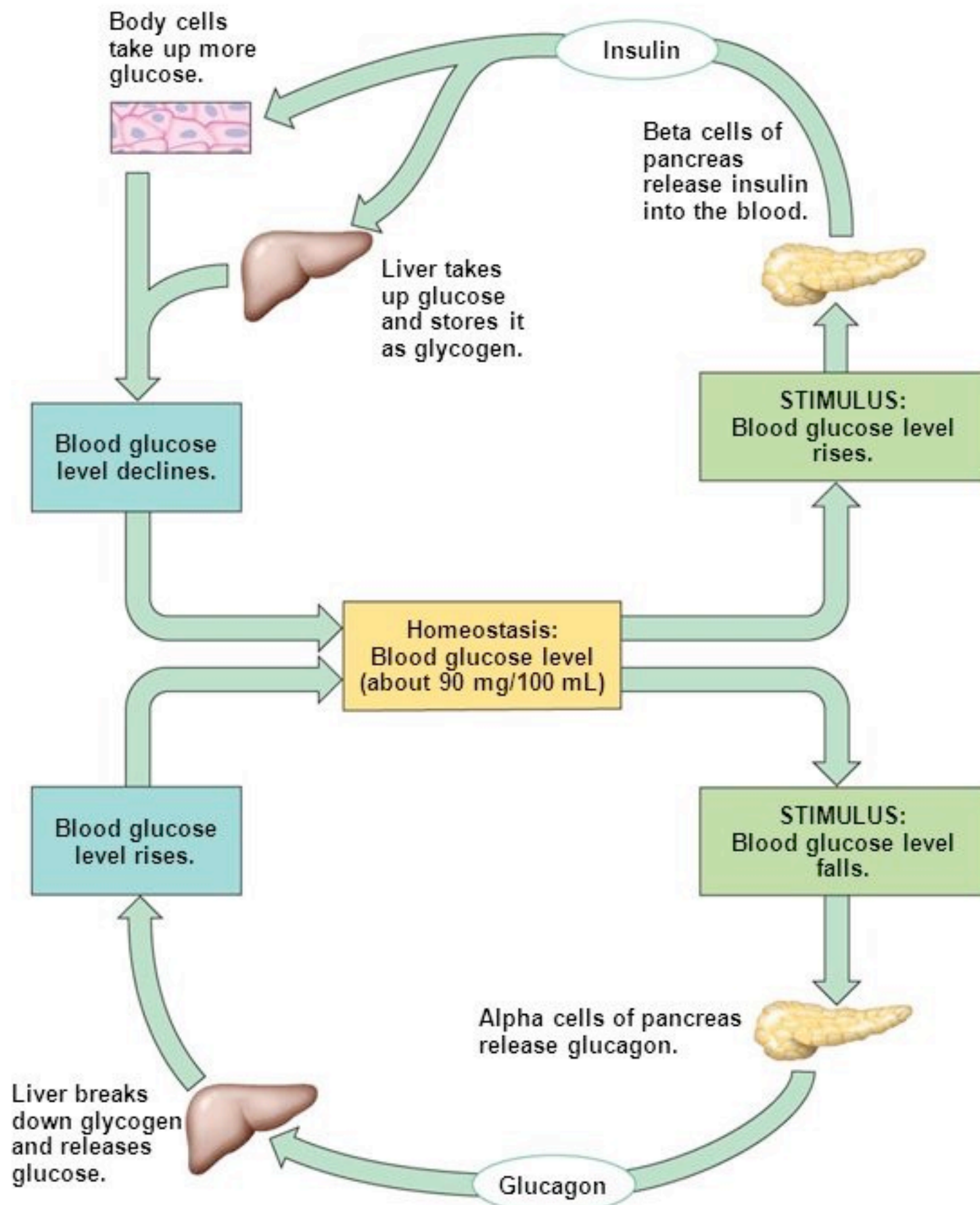
- Chemical signals that travel longer distances are known as **hormones** or **plant growth regulators**
- Hormones are found in both animals and plants respectively
- They travel in vessels or in some cases through the air
- They can be water soluble or fat soluble
- They vary greatly in size

Long Distance Signaling

common signaling cells
make up glands



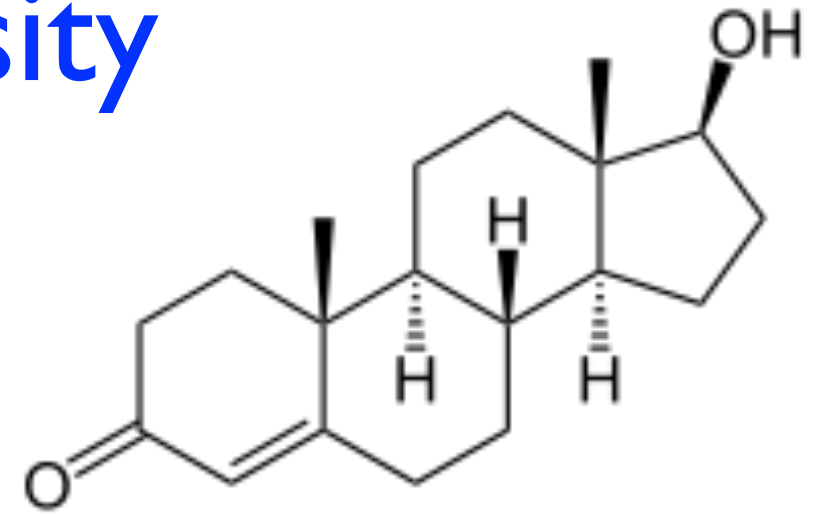
common target cells
include glands,
muscles and
neurons



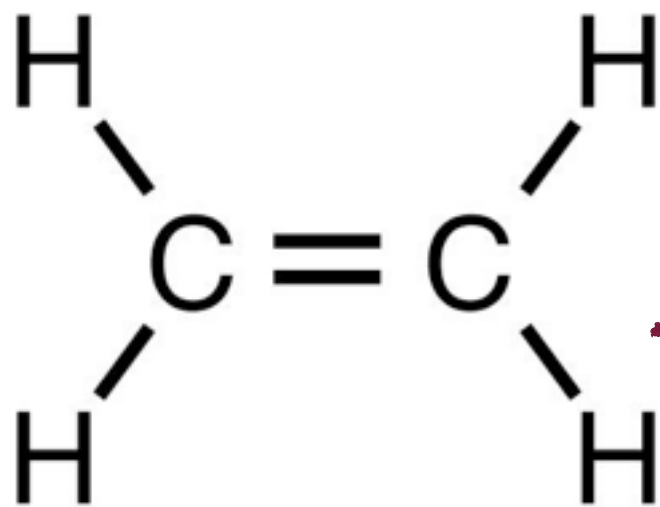
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Hormone Diversity

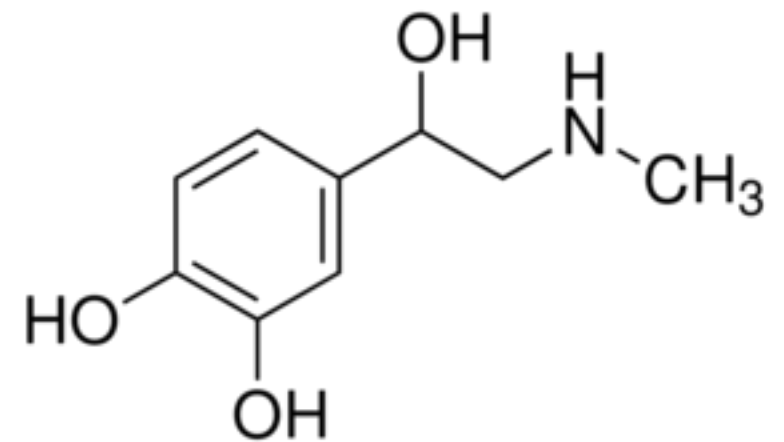
Insulin
-very large



Testosterone
-lipid soluble



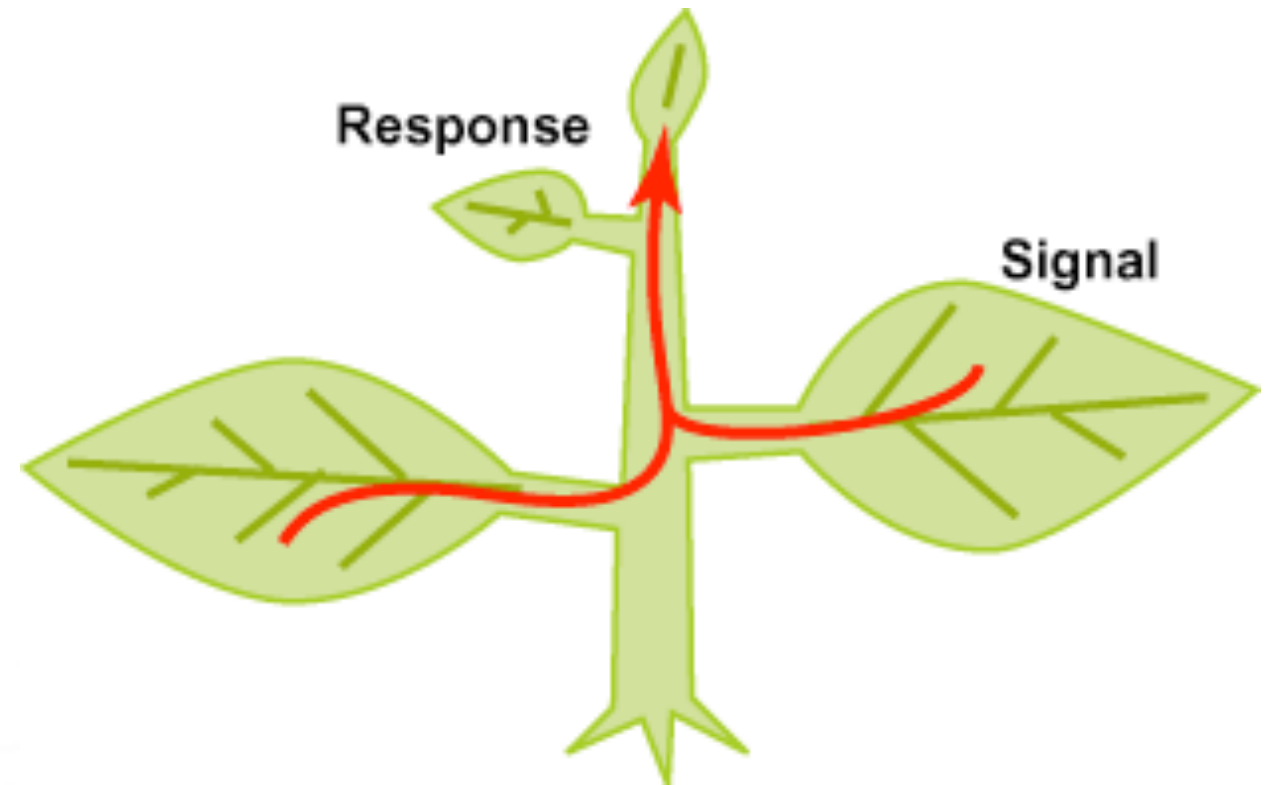
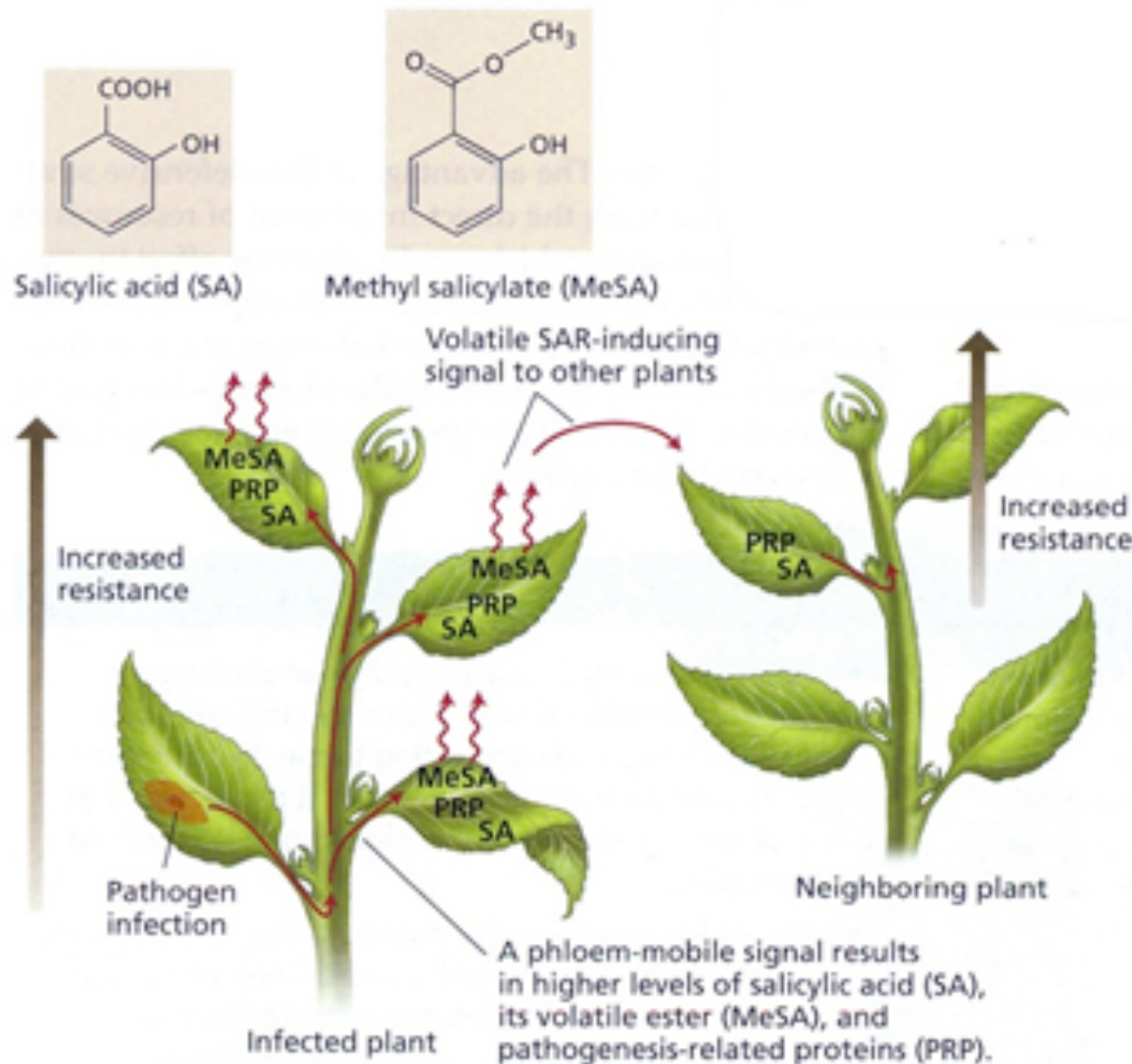
Ethylene
-very small



Epinephrine
-water soluble

Long Distance Signaling

between plants

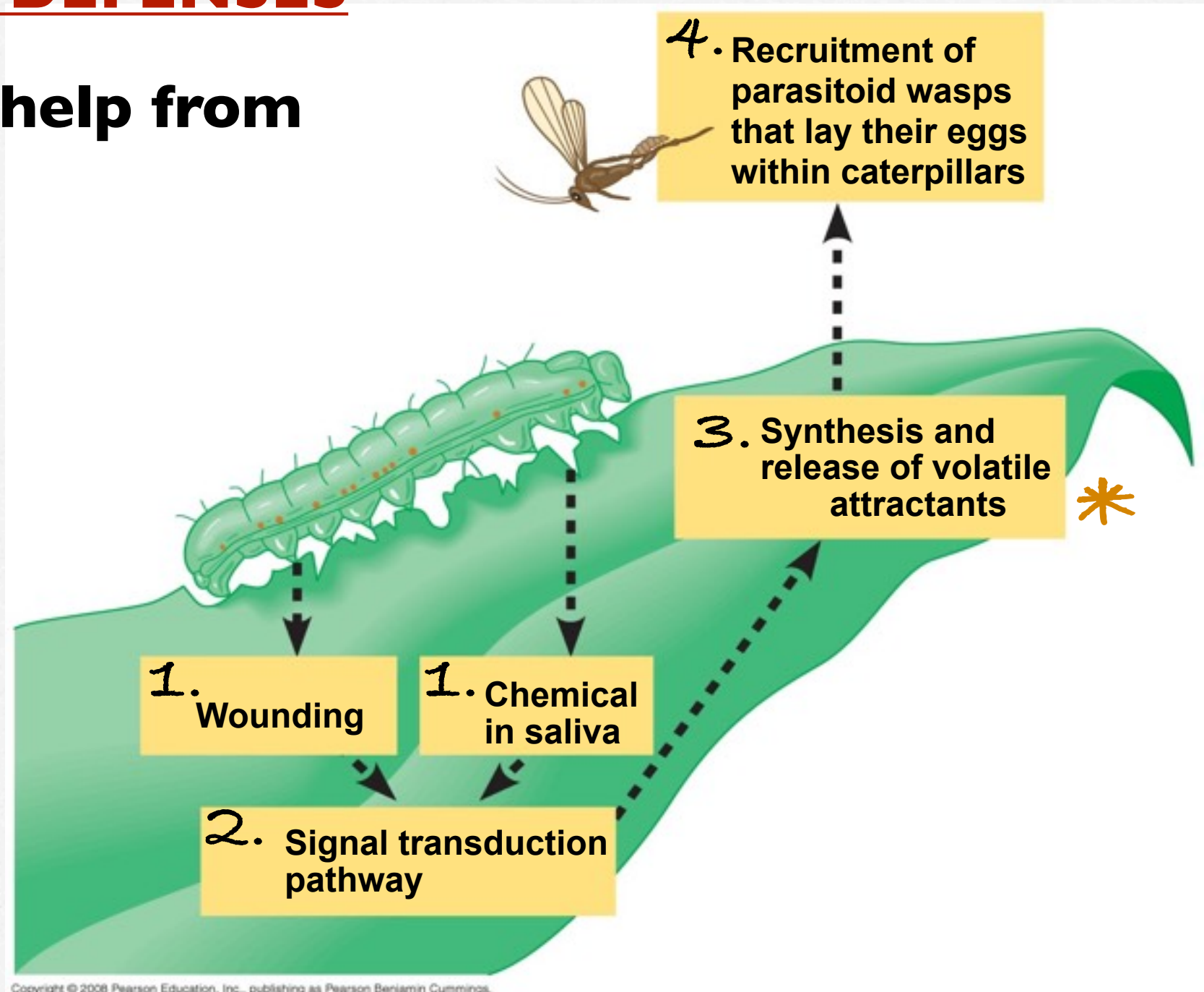


within a plant itself

Plant Defenses against Herbivores

- **RECRUITMENT DEFENSES**

- **Plants can elicit help from other species.**



Learning Objectives:

LO 3.34 The student is able to construct explanations of cell communication through cell-to-cell direct contact or through chemical signaling. [See SP 6.2]

LO 3.35 The student is able to create representation(s) that depict how cell-to-cell communication occurs by direct contact or from a distance through chemical signaling. [See SP 1.1]