Cell interaction & communication

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1. Chemotactic substance (from pipette tip) induce neutrophil polarize and migrate to the tip.

2. Staphylococcus (coccI bacteria) leave some signals catch by neutrophil that make movement and phagocytosis possible.
Objectives

Students would be able to describe and discuss the following:

1. An **importance** of cell-cell interaction & communication
2. General **principles** of cell-cell interaction & communication
3. How do cells **interact** & **communicate** to others?
4. Function of **adhesion molecules**, extra-cellular matrix and cell-cell communication molecules
5. **Cells response** to the communication & interaction
Definition

- **Cell-cell interaction:**
  - Cells contact each others or
  - contact with extracellular matrix
  - in order to form an organ or
  - facilitate communication.

- **Cell-cell communication:**
  - Ways in which living cells of an organism communicate with one another,
  - whether by direct contact between cells or by means of chemical signals
  - carried by neurotransmitter substances, hormones, cykinds, and cyclic AMP.

Which cells communicate?

- Immune-immune cells
- Neuron-neuron cells
- Hormone glands-target cells/organs
- Neighbor cells in each organ
- Host - microbe cells
- All living cells
Why cells have to interact?

1. To combine cells together to form part of organ and hold cells in its proper place, carry out a structural role
2. Be able to communicate with its neighbor
3. To facilitate biological process: growth, permeability, tissue repair, embryogenesis, differentiation.

Principles of cell-cell interaction

1. Direct contact of cells:
   a. cell adhesion molecules
   b. Gap junction: exchange signal molecules
2. Cells-extracellular matrix (ECM) contact
3. Ligand and its specific receptor molecule
Cell:Cell Contact

- The contacts are vital in multicellular organisms.
- Facilitate transport and communication
- 4 kinds of cell junction in vertebrate cells.
  1. Tight junctions: hold cell together, barrier
  2. Adherent junction: stability and integrity (belt)
  3. Gap junction: small channels for ion and metabolite
  4. Desmosomes: stability and integrity (patch)
  5. Integrin
  6. Selectin
  7. CAM

Extracellular matrix (ECM)

- Extracellular part of animal tissue
- Produced intracellularly, secrete via exocytosis
- Providing support and anchorage for cells
- Segregating tissues from one another
3 types of ECMs

1. Proteoglycan: polysaccharide gel
2. Structural proteins: collagen, elastin:
3. Fibrous adhesive protein: laminin, fibronectin, tenascin

Cell-ECM Functions

- Regulating intercellular communication,
- trap and store (relay) signals
- control cell shape and motility
- Essential for processes like
  ✓ growth,
  ✓ wound healing,
  ✓ Fibrosis
  ✓ tumor invasion
  ✓ metastasis
Integrins: important ligand binds ECM

http://humphrieslab.org/fibronectin.html

Principle of cellular communication

A. Reception
   1. Extracellular signal molecules bind to specific receptor
   2. They can act over either short or long distance
   3. Autocrine signaling can coordinate decision
   4. Many types of cell communication molecules

B. Transduction
   1. Signal transduction pathway
   2. Cross talk network

C. Response
   1. Each cell response to specific combination of signal molecules
   2. Different cell can respond differently to the same signal molecule
   3. The responses can vary from turning on a gene, activating an enzyme, rearranging the cytoskeleton
A. Reception

PRINCIPLE OF CELLULAR COMMUNICATION

1. Extracellular Signal Molecules Bind to Specific Receptors

- Specificity ***
- Two types of signal molecules
  1. Hydrophilic signal molecules bind to cell-surface receptors, which in turn generate one or more signals inside the target cell.
  2. Hydrophobic signals bind to carrier proteins, dissociate, diffuse across the plasma membrane and bind to receptors inside the target cell—either in the cytosol or in the nucleus.

2. Extracellular Signal Molecules Can Act Over Either Short or Long Distances

1. Cytoplasmic exchange:
   - electro-chemical signal through gap junction, synaps: ion, cAMP

2. Juxtacrine:
   - contact-dependent signaling
   - transmission via components of a cell membrane, integrin or ephrin
   - growth factors, cytokine and chemokine

3. Autocrine:
   - regulates on the same cell of signal source (both short or long distance)

4. Paracrine:
   - cells in the immediate area (local e.g. neurotransmitter)

5. Endocrine:
   - cells in the distance area
   - Blood vessel dependent

3. Autocrine Signaling Can Coordinate Decisions by Groups of Identical Cells

- A group of identical cells produces a higher concentration of a secreted signal than does a single cell.
- When this signal binds back to a receptor on the same cell type, it encourages the cells to respond coordinately as a group.
- quorum sensing
4. Cell communication molecules

“soluble molecules that transmit biological signals between cells”

Types of the molecules
1. Cytokines: interferon, interleukin, lymphokine
2. Growth factors
3. Hormones
4. Neurotransmitter
5. Ephrin

Cytokines & Growth Factors

- Cytokines produced by cells of the immune system that act on other cells to regulate immune system
- Growth factors control cell growth and differentiation
Amino acid & steroid hormones

- Produce by endocrine glands,
- transported in the bloodstream to the target &
- specific regulatory effect on the activity of certain organ(s)

http://legacy.owensboro.kctcs.edu/GCaplan/anat2/notes/Notes1
how endocrine works.htm

Neurotransmitter (paracrine)

- Released on excitation from the axon terminal
- Travel across the synaptic cleft
- To either excite or inhibit the target cells

http://legacy.owensboro.kctcs.edu/GCaplan/anat2/notes/Notes1
how endocrine works.htm
Ephrin (juxtacrine)

- Membrane bound signaling proteins;
- Involved in control of morphogenic changes during *embryogenesis*

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**B. Transduction**

**PRINCIPLE OF CELLULAR COMMUNICATION**
1. Signal transduction pathway

- Signal was transduced in cascade
- Finally reach its target gene
- Regulate expression of its target gene.

2. Cross talk network transduction

- To compensate some defect
- To make fine tuning for response properly
C. Response

PRINCIPLE OF CELLULAR COMMUNICATION

1. Each cell is programmed to respond to specific combination of extracellular signal molecules

- cell's dependence on multiple extracellular signals
- Each cell type displays a set of receptors that enables it to respond to a corresponding set of signal molecules.
- These signal molecules work in combinations to regulate the behavior of the cell.
2. Different cell can respond differently to the same extracellular signal molecule

- Different cell types are specialized to respond to acetylcholine in different ways.
- (A and B) two cell types, similar receptor proteins, but differently in cells specialized for different functions.
- (C) This muscle cell produces a distinct type of receptor, which generates different intracellular signals.

3. Cells respond to the interaction & communication

- Signal amplification
  ✓ autocrine
- Survival of the cells
  ✓ Differentiation: growth factors
  ✓ Regulate gene expression
  ✓ Maintain or change biochemical mechanism
  ✓ Cell dead: apoptosis
- Changes in cytoskeletal
  ✓ Conformation change: for movement
Mind map for Conclusion

References

- Wikipedia.org
- Internet resources