Chapter 43 The Immune System

First of all, take a look at Fig 42.17 to give you some background as far as the cellular and non-cellular componants of the blood.

Overview

Use Fig. 43.2 to distinguish between Innate immunity (also known as natural immunity) and adaptive immunity (also known as acquired immunity)

43.1 In innate immunity, recognition and response rely on traits common to groups of pathogens

- focus on vertebrates, skim over invertebrates
- that being said, the general process of phagocytosis shown in fig 43.3 also applies to vertebrates
- It is not necessary to memorize the names of the toll-like receptors. However, it is necessary to make a connection between this process and other cellular processes we have discussed
    - receptor-mediated endocytosis
    - signal transduction--the “innate immune responses” indicated in this diagram will be the consequence of biochemical changes initiated in the cytoplasm as a result of the transmembrane receptor binding to some molecule associated with a pathogen
- Distinguish between the role of **phagocytes** and **NK cells** in the innate response
- Describe the role of **interferons** and **complement proteins** (see fig 43.19 for more on complement)
- Think about the symptoms associated with **inflammation**. Be able to describe action of innate immunity that underlies each one
    - redness
    - swelling
    - pus (yuk)
    - fever
- Recognize histamine as the primary signalling molecule that induces inflammatory responses

43.2 Adaptive Immnity...receptors...

SPECIFICITY

- notice how the antigen receptors found on **B and T cells** differ from the TLR receptors in terms of specificity...
- notice how the antigen receptors found on B cells differ from the antigen receptors found on T cells; relate this structural difference to the difference in the manner that each cell type interacts with antigens
- It is not necessary to master the details of how the receptors are constructed
    - however, it is necessary to grasp the idea that these structures are modular. This is the basis for the diversity of lymphocytes that operate in adaptive immunity

    - be able to describe, in general terms, how gene rearrangement in the stem cells of the bone marrow results in populations of T and B cells with extraordinary diversity of antigen receptors

SELF TOLERANCE

- The body's own cells are excluded as targets of the immune system based on the presence of the **MHC molecule** on the surface of the cell membrane
    - The MHC molecule is a complex protein with multiple subunits (think quaternary structure)
    - There are multiple alleles in the human population for each subunit
    - Consequently, the MHC complex is unique for each for each individual (except for identical twins)
- Before new B cells or T cells are released into circulation, they are "tested" against the MHC complex of the body's own cells; any lymphocytes that prompt an immune response against the MHC are destroyed

<u>43.3 Adaptive Immunity...</u>

- Use fig. 43.20 to organize your thinking.
    - what is the distinction between the **humoral response** and the **cell-mediated** response?
    - which cells are **antigen-dependent**?
    - what does it mean for a lymphocyte to become "**activated**"
    - what is the consequence of **clonal selection**?
    - describe the role of each type of lymphocyte, then check the detail of your understanding with fig. 43.12, 43.13, 43.16, 43.17, and 43.18
- Distinguish between a **primary and a secondary immune response**
- Distinguish between **passive and active immunity**
- Explain how **vaccines** manipulate the immune system to protect against infection

<u>43.4 Disruptions in immune system function..</u>

Please read this section for the gist of it. There are good examples that give context for the specific details of the immune response.

Chapter 45 Hormones and the Endocrine System

<u>45.1 Hormones and other signalling molecules...</u>

- Figure 45.2 is a good summary. What distinguishes endocrine signals (and neuroendocrine signals) from the others?
- Distinguish between hormones and pheromones
- Identify structural and functional differences between peptide hormones and steroid hormones: Fig 45.5 and 45.6
- Distinguish between the biochemical pathways that
    - directly influence protein activity in the cytoplasm Fig 11.12, 11.16
    - indirectly influence protein activity in the cytoplasm via regulation of gene

expression Fig 45.8

- Note that one signal can result in *various* responses depending on the nature of the biochemical pathway that is activated in the specific target cell: Fig 45.9

45.2 Feedback regulation and antagonistic hormone pairs

- Distinguish between negative feedback and positive feedback
- Which feedback mechanism is characteristic of pathways that help maintain homeostasis? Do you know what homeostasis is...?
- Feedback mechanisms are not unique to the endocrine system. Do you remember phosphofructokinase?

45.3 The hypothalamus and pituitary

- Describe the structural relationships between the hypothalamus and each lobe of the pituitary gland
- Describe the functional relationships between the hypothalamus and each lobe of the pituitary gland
- The pituitary gland is sometimes nicknamed “the master gland.” Why?
- Notice that each of the hormones named in Fig 45.16 is under the control of a specific releasing hormone and a specific inhibiting hormone secreted by the hypothalamus
- Please don’t try to memorize Table 45.1. This would be a waste of your time
- What distinguishes a tropic hormone from other hormones?

Read the rest of this section to get a sense for some useful examples. Do not memorize.

45.4 Endocrine glands respond to diverse stimuli

Read this section to get a sense of the overall functions of the endocrine system. Use the chart we put together in class to organize your understanding of this section. The chart is not a substitute for reading. Be prepared to answer questions that describe a scenario related to one of the endocrine pathways.

Chapter 48 Neurons, Synapse, and Signalling

48.1 Neuron Organization and structure...

- Our focus is on the transmission of electrochemical signals between neurons. However, I think it is important to put this in the context of the function of the nervous system, overall.
    - Sensory input includes neurons that respond to the external environment (like photoreceptors in the eye) as well as neurons that respond to the internal environment (like baroreceptors that detect blood pressure changes in the carotid artery).

        - Output from the peripheral nervous system includes both functions under voluntary control (like skeletal muscle contraction) and functions that are "automatic" (like heart rate).
        - see fig 48.3 and 49.7
- Be able to identify the distinguishing structural features of nerve cells, fig. 48.4

<u>48.2 Ion pumps and ion channels establish the resting potential of a neuron</u>

- Study fig. 48.7 carefully. Notice:
    - Which structure(s) are involved in active transport? Which structure(s) are involved in passive transport?
    - What is the relevance of the fact that 2 potassium ions are transported into the cell for every 3 sodium ions transported out?
    - What is the relevance of the fact that potassium ion channels outnumber sodium ion channels in the neuron cell membrane?
- you are not responsible for the fancy physics equation
- you are responsible for understanding that a nerve cell at rest (not stimulated) has set up an imbalance of charge across the cell membrane

<u>48.2 Action potentials are the signals conducted by axons</u>

- a nerve impulse is known as an action potential
- **voltage**-gated ion channels are responsible for transforming the electrical signal received by dendrites on the cell body to an electrical impulse that is transmitted down the axon to the synaptic terminal of the receiving cell
- an action potential is only generated in response to an electrical stimulus that depolarizes the resting potential from about -70 mV to about -55 mV.
- Use the animated "activity" on the CD rom that accompanies your book to assist you as you study fig 48.11
    - make sure you can distinguish between the role of the voltage gated ion channels relevant to the action potential and the plain old ion channels related to resting potential
    - it is important to realize that the sodium gated ion channels close *before* the potassium gated ion channels--why is this important
- be able to explain the functional significance of the refractory period
- be able to explain how the movement of ions ensure that the electrical signal is transmitted in one direction: from the origin of the axon at the cell body to its terminus at the synapse
- be able to explain the adaptive significance of myelination and saltatory conduction seen in the neurons of vertebrates, fig 48.14

48.4 Neurons communicate with other cells at synapses

- In most cases, the electrical signal that reaches the axon terminus is transformed into a chemical signal that initiates depolarization of the target neuron
    - notice the role of Ca^{2+} as a second messenger in this signalling system
    - notice that the neurotransmitter receptor also functions as an ion channel
- variety of responses depends on the type of gated ion channel displayed on the membrane of the post-synaptic cell
    - excitatory
    - inhibitory
- One neuron may respond to multiple other pre-synaptic neurons, fig 48.17
    - this allows for the central nervous system to integrate signals received from many different stimuli at once
    - a co-ordinated response may then be initiated by the central nervous system

Read the last section on neurotransmitters to get the general idea. You are not responsible for memorizing these. Be prepared to answer questions that require you to interpret a scenario involving one of these neurotransmitters.

Chapter 49 Nervous Systems

I recommend that you read 49.2 and 49.3. It's interesting. This will not be a chore. Do it. I will not be holding you responsible for specifics. The general concept that I *am* holding you responsible for is that specific regions of the brain are specialized for specific functions. For this, you must read closely the text that accompanies fig 49.9.