**Microbiology for Nursing**
**Exam #3 Review**

1. What is the high energy currency ? What is produced from ATP when energy is used?

**ATP –** Adenosine Tri-phosphate (high energy) → ADP Adenosine Di-phosphate (low energy)

2. What are coenzymes? What are the two coenzymes used in respiration?

**Coenzymes:** Molecules that act as electron carriers between redox reactions (i.e., electrons that carry $H^+$ ions).
**FAD**
**NAD**

3. Define and be able to contrast oxidation or reduction.

**Oxidation:** The removal of electrons ($e^-$) from a molecule, more positive charge.
**Reduction:** The addition of electrons ($e^-$) to a molecule, more negative charge.
OIL-RIG: Oxidation involves loss, Reduction involves gain.

4. Define fermentation and explain what happens to the electrons and hydrogen ions from $NADH_2$ in fermentation.

**Fermentation** in respiration is oxidation without an outside electron acceptor, only yields two ATP molecules per glucose molecule.
The hydrogen ($H^-$) ions are stored onto a $NADH_2$ molecule and put back onto pyruvic acid to form acids or alcohols. This prevents further respiration from being blocked due to all the NAD being used.

5. Name three chemicals produced by fermentation.

lactic acid, ethyl alcohol, acetone

6. Name three products produced by fermentation.

Fuel, Beer and Cheese

7. Define anaerobic respiration. How is the electron transport system used in anaerobic respiration?

**Anaerobic respiration**: Oxidation where something other then oxygen is the electron acceptor.
Anaerobic respiration uses the electron transport system in the cell membrane that is used in aerobic respiration. Less energy is produced in anaerobic respiration that aerobic because not all of the protein carriers in the membrane are used.

8. Name the three common electron acceptors used in anaerobic respiration.
Nitrate ($NO_3^-$), Sulfate ($SO4^-$), or carbonates ($CO_3^{-2}$)

9. Name three chemicals commonly produced by anaerobic respiration.
Methane, Hydrogen sulfide, Nitrogen gas

**********IMMUNE SYSTEM**********

10. What are three things the lymphatic system does? How is lymph fluid reabsorbed back into the lymphatic system?

A. collects fluid from the tissue and returns it to the blood
B. Returns proteins to the blood.
C. Carries bacteria and viruses from the tissues to the blood.
D. Moves lipids from the small intestine to the blood

Fluid moves into the lymph capillaries through intercellular clefts in the walls of the lymph capillaries. The vessels are held open by connective tissue fibers and the intercellular clefts act as a one way valve so the fluid from the tissue can move in through them, but not out. These openings also allow the bacteria and viruses to move from the tissue to the lymphatic system.

11. How are lymph nodes and the spleen alike and how are they different?

| LYMPH NODES | SPLEEN | BOTH |
|---|---|---|
| have white pulp only | have red pulp & white pulp | |
| | have more blood circulating | |
| | | |
| | | |

12. Explain the difference between specific and non-specific immunity with respect to activation, specificity of attack, and how well each is at removing an antigen.
**Non-specific –** Does not require activation, recognizes any foreign materials and attacks. Not very effective.
**Specific –** Must be activated. attacks specific antigens. Very effective at attacking that specific antigen.

13. List the parts of the non-specific or specific immune system and the function of the parts.
**Non-specific:**
Natural killer cells: Lymphocytes found in the spleen, liver, lymph nodes, and bone marrow that bond to foreign cells causing them to lyse. Can also lyse some tumor cells.
Neutrophils: Circulating white blood cells that phagocytize foreign cells.
Reticuloendothelial system (R.E. System): Has two parts.
1. circulating monocytes (in the blood) that phagocytize foreign cells
2. Fixed macrophage found in spleen,liver, lymph nodes, and the bone marrow. Both phagocytize foreign cells.
Complement: 20 serum proteins that form the membrane attack complex which creates holes in the membranes of foreign cells.

**Specific:**

T-Cells (Cell mediated immunity) – lymphocytes that attack antigens directly.
B-Cells (Humoral immunity) – lymphocytes that produce antibodies

14. What is the major histocompatibility complex? Explain how these proteins function in cells. Explain the difference between in function and location of MHC-I and MHC-II proteins.

**Major Histocompatibility Complex –** Antigens found on the surface of cells that mark cells as from the body or foreign.

**MHC-I –** Proteins found in the membranes of all cells except red blood cells. MHC-I can only present endogenous antigens (antigens from pathogens living within the cell).

**MHC-II** – Proteins found on special cells called antigen presenting cells.
These are found on: macrophages/monocytes, B-Cells, Kupffer cells in the liver, microglia cells of the CNS, Langerhans cells of the skin, dendritic cells of the lymph nodes and spleen.
Can present antigens from either endogenous or exogenous pathogens.

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15. Explain in detail how B-cells or T-cells are activated. What is costimulation?

**T-Cell Activation:**

1. T-cell recognizes and bonds to a cell that is presenting foreign antigens on it's MHC1
2. Elsewhere a macrophage digests the same antigen and presents it on it's MHC2
3. T-4 helper cell bonds to the macrophage and causes the release of Interleukon1
4. T-4 helper cell divides and releases Interleukon2
5. the cell is eventually lysed

**B-Cell Activation:**

1. B-cell bonds to antigens that are free floating in the blood
2. Elsewhere a macrophage digests the same antigen and presents it on it's MHC2
3. T-4 helper cell bonds to the macrophage and causes the release of Interleukon1
4. T-4 helper cell rapidly divides
5. T-4 helper cell bonds to the B-cell and releases Interleukon2
6. This activates the b-cell to produce antibodies

**Costimulation of T-Cells:** The second signal that fully activates the T-cell. Activation can not occur without costimulation. In T-cells, the costimulatory signal is from a T4 helper cell. (Interleukon1 is a costimulatory signal for T4's)

16. What is the difference in how cytotoxic T-cells and B-cells attack antigens?

**Cytotoxic T-Cells** (activated T-Cells) bond to MHC-I/foreign protein complex on cell membranes and kill the cell by injecting lysozymes (perforin, lymphotoxin) into the cell or by activating apoptosis genes which cause the cell to die. They also produce interferon which prevents viral replication in the cell.

**(Plasma)cells activated B-Cells** (activated B-Cells) divide rapidly and produce proteins called antibodies that attack the specific antigens. Antibodies cause antigens to be bonded together (agglutination), which increases their destruction by macrophages and other immune system

cells.

17. What do B-cells attack and what do T-cells attack?

**B-Cells primarily attack:**

Bacteria

**T-Cells primarily attack:**

Transplanted tissue
Cancer cells
Viral infections
Fungal infections
Parasites

18. How are the five classes of antibody different? Which are most common and least common in the blood? Which class crosses mucus membranes? Which class crosses the placenta? Which classes act as receptor sites on B-cells? Which classes are involved in allergic reactions?

**IgG –** 75%, **-** Protects against: Bacteria & Viruses
**-** Only class that cross placenta
**IgA –** 15%, **-** Protects against: Bacterial and viral infections of mucus membranes
- Crosses mucus membranes
- Often involved in allergic reactions including food allergies
**IgM** – 10%- Acts as antigen receptor on B-Cells
- Involved in food allergies.
**IgD** – 1%, Acts as antigen receptor sites on B-Cells
**IgE -** < 0.1%, Mast cells, Basophiles
- Triggers histamine release- Involved in allergic reactions

| | |
|---|---|
| Mucus membranes | IgA |
| Placenta | IgG |
| act as antigen receptor sites on B-cells | IgM & IgD |
| Allergic Reaction | IgA, IgM, IgE |

19. Why does immunization work? Be able to explain the primary and secondary immune responses.

Immunization involves the process of inducing a small amount of a foreign substance into the body so that the B-Cells and T-Cells can become activated against this particular antigen. Once activated some of the T-Cells and B-Cells produce memory cells which remain and are already active to fight this specific antigen. Therefore, when the antigen appears again, these cells will begin the fight much faster before the foreign cells have become established. This second and faster response is called the secondary or anamnestic response.
Also, in the primary (first) response to an antigen, the body produces equal amounts of IgG and IgM antibodies. In the secondary response the body produces 4-5 times as many IgG antibodies as it does IgM.

20. What causes type I hypersensitivity allergic reactions and how can they be treated? What happens in anaphylactic shock and how can it be treated?

Type I hypersensitivity = anaphylaxis/immediate hypersensitivity.
- Reactions occur within minutes
- Repeated exposure to an antigen causes sensitivity to it and IgE antibodies attach to the surface of mast cells and basophiles in mucus membranes and cutaneous membranes.
- when the antigens enter the body, they bond to the antibodies on the mast cells and basophiles causing them to release histamine, prostaglandins, leukotrienes and kinin. These compounds cause inflammation, vasodilation, tissue swelling, increased mucus production and contraction of smooth muscle in the lungs.
- Responsible for allergies, can be as minimal as eyes watering and itching to life threatening (anaphylactic shock)
- Anaphylactic shock = hives,blood pressure drops dangerously low 60mm hg, bronchioles/throat may constrict blocking the airway. Tx: epinephrine to increase blood pressure, antihistamines or albuterol to open up the airway.

21. What occurs in type II hypersensitivity reactions.

Type II = Cytotoxic reactions or antibody dependent
Typically take 1-3 hours to occur.
Reactions to foreign blood in the body, involve IgG, IgM antibodies and complement
Cause blood rejection when the wrong blood type is given.

22. Explain what happens in type III hypersensitivity reactions and why they can cause autoimmune diseases.

Type III = Immune complex disorders (autoimmune diseases)
Typically take 1-3 hours to occur.
Involve IgA, IgM antibodies and complement
Occur when certain ratios of antigen to antibody occur in the body, the antigen/antibody complexes are small and become trapped under the basement membrane of the endothelium of blood vessels, causing inflammation and constriction of the vessels and thus greatly reducing the blood flow through them.
Causes several autoimmune diseases: lupus, glomerulonephritis and rheumatoid arthritis.
**Lupus:** also damages tissue in the body when the antigen/antibody complex is attacked by other parts of the immune system.
**Glomerulonephritis**: causes inflammation in the kidneys leading to damaged kidney tissue and scar tissue in the kidneys, thus reduced function of kidneys.
**Rheumatoid arthritis:** Attack of the antigen/antibody tissue causes damage to the synovial membranes, which grow thicker as they repair the damage.

23. What are haptens and explain how they are involved in type IV hypersensitivity allergic reactions?

Type IV = delayed hypersensitivity
Typically take 12-72 hours
Can be transferred to a person during a blood transfusion.
Involve activated T-Cells (also T-4 helper cells and macrophages)
Important for protecting the body from parasite, viral and fungal infections, also involved in transplant tissue rejection.
Molecules from antigens called **haptens** move across the mucus membrane or cutaneous

membranes and bond with proteins. The antigen/antibody complexes are picked up by antigen presenting cells such as Langerhans cells in the skin and migrate to the lymph nodes, where they present their antigens to T-Cells. The activated T-Cells release interferon which activates the macrophages to release tumor necrosis factor which causes inflammation and rashes of the skin (dermatitis).
**Common haptens**: poison oak, poison ivy, cosmetics, deodorants, and heavy metals.

24. What are gamma globulin shots and what do they do?
Gamma globulin injections are usually given in an attempt to provide a temporary boost to a patients immunity against a disease. Typically used for those exposed to Hepatitis A or measles. Gamma globulin shots contain fused cells made up of a plasma cell (activated B-Cell) and a tumor cell. These cells grow rapidly and produce large quantities of a single type of antibody (monoclonal antibodies).

25. Explain how an ElISA test is done and what it tests for.
**ELISA –** Enzyme-linked immunosorbent assey.
Test for antibodies to a pathogen in the blood sera.
A. A known antigen is attached to absorbent plastic in the bottom of a test well.
B. Blood sera is added to the test well, if the antibodies are present, they will attach to the antigens.
C. The well is washed out, removing any unattached antibodies.
D. The enzyme peroxidase is then added, it will bond to the antibodies.
E. The well is again washed out so that any unbonded peroxidase is removed.
F. Chromogen (a colorless substrate) is then added, when chromogen bonds to peroxidase it will become colored.

NOTE: in Radioimmunoassay instead of adding the enzyme peroxidase, a radioactive molecule is added that attaches to the antibodies.

26. Explain how a Western blot test is done. How is a Western blot different from a southern blot test.
A. Specific pathogen antigens are separated out by size using gel electrophoresis.
B. The gel is blotted with a sheet of nitrocellulose and the nitrocellulose picks up the pathogen proteins.
C. The nitrocellulose paper is then incubated in the blood sera to be tested. If the antibodies for the specific disease proteins are present they will bond to the proteins on the nitrocellulose paper.
D. The paper is then rinsed to remove antibodies that have not bonded to the antigens.
E. An ELISA or RIA test is then used to determine if antibodies have bonded to the antigens making bands on the nitrocellulose paper.
**Differences from Southern blot test:**
- After separation the western blot test uses ELISA or RIA to read the results.
- southern blot test for specific DNA sequences, where western blot tests for proteins or antigens.

27. Explain how a hemagglutination test is done and explain what it tests for.
Tests for exposure to specific viruses like measles. Can be used with any virus that agglutinates red blood cells.
A. Red blood cells are mixed with a known virus and blood serum from the person being tested.
B. If the viral antibodies are present they will bond with the virus and preent it from agglutinating the red blood cells. A positive test for exposure to the disease results in no agglutination of the red blood cells.

28. Explain how the complement fixation test is done and what tests for.

Allows for the identification of either antibodies or antigens. Requires four components: antibody, antigen, complement and sensitized sheep red blood cells.
A. First the antigen and antibodies are allowed to react.
B. A complement is added to the mixed antibodies/antigens. If the antigen and antibodies bonded, then the complement will complex with them and not be available to react with the blood cells.
C. Sheep blood cells are added to the mix. Positive test: (antigen and antibodies bonded)blood cells will not lyse. Negative test:(antigen and antibodies did not bond)blood cells will lyse.

29. Explain how direct fluorescent antibody testes are done and what they test for.

Tests to identify pathogens using antibodies.
A. The unidentified microorganism to be tested is fixed to a slide which is then flooded with antibodies to a give pathogen that have a fluorescent molecule bonded to them.
B. The unbonded antibodies are then washed off
C. If the slide is fluorescent (glows yellow-green), then the antibodies bonded to the unidentified pathogen.

30. List and explain 5 things in the body other than the immune system that help prevent infection and disease.

**Epidermis of the skin**: forms a barrier to parasite and microbe infection
**Mucus membranes**: Help prevent microbes from moving into the body
**High acidity of stomach:** Many parasites cannot pass through without being in a protected egg.
**IgA antibodies:** The only antibodies that can cross the mucus membrane.
**Human Milk:** Carries substances that kill Entamoeba, histolytica, and Giardia lamblia.
**Inflammation:** Tissue swells so lymphocytes can enter the area and attack foreign cells.
**Fevers:** Higher temperatures during an infection increases the effectiveness of interferon and phagocytic activities of macrophages while hindering the replication of some pathagens.

31. How does the HIV virus affect the immune system?

HIV/AIDS knocks out the T-4 helper cells preventing activation of the specific immune systems.

32. What causes general adaptation syndrome and what does it cause to happen? Explain how it affects susceptibility to infection and disease

GAS is caused by stress.
Response to stressor:
Decrease in immune system for energy conservation
Increase in susceptibility to disease