Understandings:

1. Explain what antigens are.

- Antigens are what all cells have. But usually, we refer antigens as molecules that may trigger an immune response. Most of them are proteins and polysaccharides.

Example is hemagglutinin and neuraminidase.

Extra notes

- Before we dig in deeper, I think we should clarify some terminologies.

White blood cells = Leucocyte. Note that this is a rather large group.

1. Macrophage. They are also a type of phagocytes, which are cells that engulf.

2. Lymphocytes. We have T lymphocyte and B lymphocyte. You will find more detail right below.

2. Explain the interrelationship between B lymphocytes and T lymphocytes in mammals.

- Our body has been challenged by some foreign antigens. It is time for us to respond.

Firstly, macrophages eat the bad boys. It digests them with lysozyme and puts the pathogen's antigen on its surface.

Secondly, T helper cells stroll down and test if any of them match the presented antigen. Eventually, there will be this lucky guy who fits the antigen. The helper T cell signals for help, hence the name helper T cell.

Thirdly, B cells check if any of them fit the presented antigen from the T cell.

Well, now the B cells are ready for some action. They can either produce plasma cells or memory cells.

3. Plasma cells secrete antibodies.

- The B cells divide to produce plasma cells that are specific to the antigen of the pathogen. This is called clonal selection.

These plasma cells are the factory for antibody production. Since they must produce a lot of antibodies, the protein production must be specific and efficient.

Therefore, it has a lot of rough ER to modify and transport antibodies outside the cell membranes. The genes in their nucleus are very specifically expressed.

4. Activated B cells multiply to form clones of plasma cells and memory cells.
- We have mentioned plasma cells. Along the plasma cells, smaller numbers of memory cells are produced.

Usually, the antibodies produced by plasma cells die within weeks so the body has evolved to find a more long term memory. Thus we have memory cells. These may remain from years to the entire life. When previously visited pathogens infect the body again, the memory cells can act quicker by skipping the "macrophage and helper T cell"-step.

It might be important to note that time is the main weakness in our immune system. If the respond would be faster, we are theoretically able to fight any disease.

5. Antibodies aid the destruction of pathogens.
- Antibodies fight off pathogens, but how? There are many ways.

1. Opsonization. This is a medical term. It is when antibodies handcuff the pathogens and links them to phagocytes (any cell that can ingest).

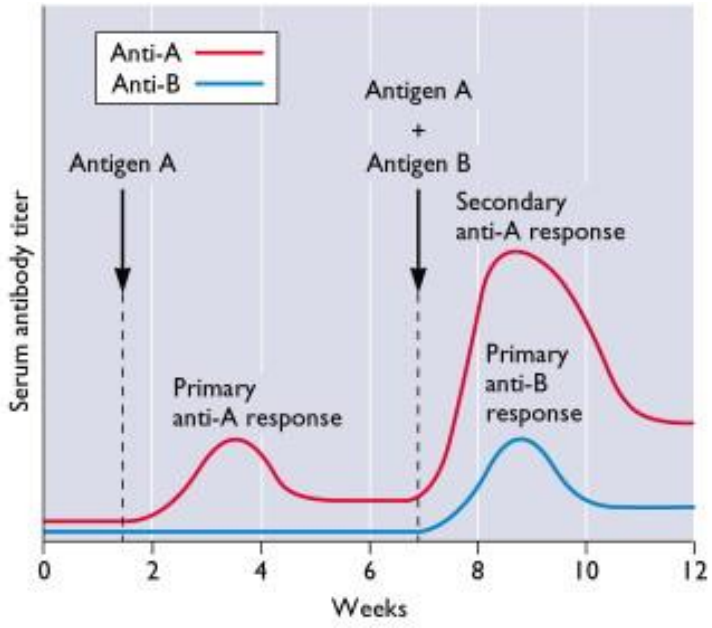
2. Neutralization. It is when the viruses and bacteria are held/neutralized so they cannot bind to any host cell.

3. Neutralization of toxins. Some pathogens might secrete toxins (exotoxins). Some cells in our body are susceptible (vulnerable) to that thus antibodies hold them off.

4. Activation of complement. A complement is a set of proteins. Antibodies activate this set of proteins on the pathogen membrane. This makes the membrane more porous and the pathogen will burst.

5. Agglutination. Antibodies stick pathogens together so phagocytes can ingest more at the same time.

6. Explain immunity.
- When we say "good immunity", we are referring to how fast our body can produce antibodies. We know that this depend on the memory cells.



We can see that the initial response of Antigen A takes longer than the second time Antigen A enters.

This is due to the memory cells that have been saved in the Primary anti-A response.

7. Explain how vaccines work.

- The main idea is to trigger the primary response in a harmless way. Thus one can inject dead pathogen, attenuated/weakened pathogen, a dead/attenuated sibling pathogen, subunit/derivative of pathogen.

When the real pathogen strikes, our body can act fast.

Vaccines are usually injected or orally swallowed. The main disadvantage of oral vaccination is that some pathogen may stay and live in the airways of the vaccinated person. The person is now immune to it, but when that person coughs, it may infect a nearby person who is not vaccinated. So once WHO decides to eradicate a pathogen through oral vaccination, they must make sure EVERYONE gets it.

Extra notes

- I believe you should know what active and passive immunity is in case this question comes up on the exam.

Active immunity is when the body produces antibody itself. This can be by acquiring the disease or through vaccine.

Passive immunity is when the body is given the antibodies. This can be through placenta, breastfeeding or blood transfusions.

8. State that pathogens can be species-specific although others can cross species barriers.

- Pathogen can be species specific. Swine and avian influenza are examples. Humans are the only species so far that are vulnerable to polio, measles, and syphilis.

But there are pathogens called zoonosis. This is a set of pathogens that may cross form one species to another. This is becoming more prevalent as humans live near animals and destroy their habitat.

9. Explain the initiation of histamine.

- When there is infection, we also have mast cells and basophils (type of WBC) working as well. These cells secrete histamines (a molecule with Nitrogen) that increase permeability of the capillaries. This enables blood to travel to the infected areas and thereby our leukocytes can do the job.

10. Explain how histamines cause allergic symptoms.

- Histamine initiates allergic reactions. Cells have some histamine receptors here and there that can cause the allergic symptoms.

Often, harmless molecules like pollen might cause immune response, leading to mass production of histamine.

11. Explain how a hybridoma cell is produced.
- Hybridoma cell is an artificially fused cell that is used to fight a specific pathogen. The principle is to fuse plasma cell with a tumor cell.

First, antigen is injected. This will initiate the immune response and there will be many plasma B cells with different antibodies that are there to "test" the antigen.

Second, the plasma B cells are extracted.

Third, the cells are fused with a tumor cell called myeloma cell. This new cell is called hybridoma cell, and will divide rapidly.

12. Explain how monoclonal antibodies are produced by hybridoma cells.
- Monoclonal antibodies are specific antibodies that are purified. Thus they all target the same antigen.

Out of all the different hybridoma cells, each must be tested to see which one it is that have the response to antigen. Once identified it is left to divide.

Skills and applications:

1. Explain the eradication of smallpox.
- Smallpox was the first eradicated disease. Everyone agreed worldwide to take part in 1950s.

The first reason why this worked is because the pathogen is species specific only to humans. Thus it cannot stay dormant in another species and reappear.

The second reason is because symptoms were clear and fast emerging. Thus before the person could infect more people, they were treated on prompt.

The third reason is that memory cells for smallpox are life-lasting. The person cannot be re-infected.

2. Explain how monoclonal antibodies to hCG are used in pregnancy test kits.

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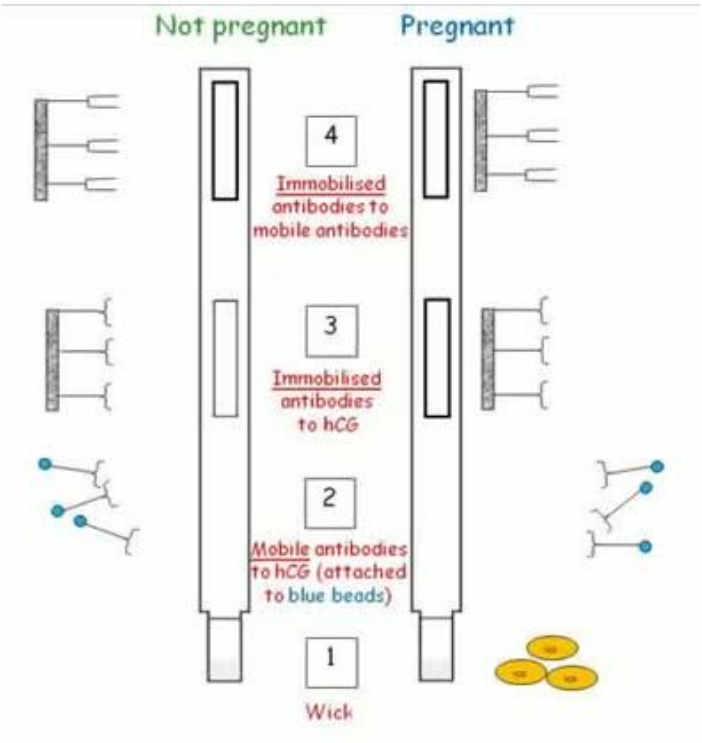

The pregnancy test kit contains monoclonal antibodies that bind to hCG (unique during pregnancy).

First, the person needs to urinate on the strip.

The urine will wash down the dyed mobile antibodies. Now, if there is hCG present, the hCG and dyed antibody will move to point 3 and bind there.

The remaining mobile antibodies continue down to bind with the antibodies without hCG.

This means that there will be two strips!

If hCG is not present, strip will be present in only point 4.

3. Explain different blood groups in terms of antigens.

- We have 4 different types of blood groups as we all know. ABO, AO, BO and O. These letters are actually just antigens that sit on the surface of erythrocytes (RBC)!

This is important to know during blood transfusion. If one injects blood with an antigen that our body does not have, it will form an immune response. Blood may coagulate and block and burst vessels.

This means that O can give to everyone since everyone has O antigen present. ABO can accept everyone since it has all the antigens present.

Extra notes

- I just read an interesting article (right now it is October 2015) about males with brothers having higher chance to be homosexual than males without brothers. This is relevant here in this chapter because a very likely explanation is due to the antibody production in the mother.

It is thought that having a first male child triggers a certain antibody response in the mother. When the mother is pregnant again with the second male child, the residues of antibodies produced somehow affects the brain orientation that may make the child prone to homosexuality.

More in general terms, the second child is almost always likely to be affected by antibodies if the first child triggers a certain antibody response in the mother. This of course assumes that the second pregnancy is relatively close to the first pregnancy so the memory B cells remain.

4. Be able to analyze of epidemiological data related to vaccination programs.

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