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VCE Biology ¾
Introduction to Immunity [3.1]
Homework Solutions

Admin Info & Homework Outline:

Student Name	
Questions You Need Help For	
Compulsory Questions	Pg 2-Pg 19

Section A: Compulsory Questions (37 Marks)

Sub-Section [3.1.1]: Define the Terms Antigen, Pathogen, Allergen, Cellular & Non-Cellular, & Describe the Difference between Self & Non-Self

Question 1

Define the following.

a. Antigen:

A substance that triggers an immune response, often a foreign molecule, such as a protein on the surface of a pathogen.

b. Pathogen:

An organism or agent (e.g., virus, bacterium, fungus) that causes disease in its host.

c. Allergen:

A substance that causes an allergic reaction, usually by triggering an immune response to a harmless substance (e.g., pollen, pet dander).

d. Cellular:

Refers to living organisms or components made up of cells, such as bacteria or human cells.

e. Non-cellular:

Refers to entities not made of cells, such as viruses or prions.

f. Self vs Non-self:

i. Self:

Molecules or cells that belong to the body and are recognised as "self" by the immune system.

ii. Non-self:

Molecules or cells that are foreign to the body, such as pathogens or transplanted tissues, which are recognised as "non-self" and often targeted by the immune system.

Question 2 (1 mark)

A patient is diagnosed with a viral infection caused by the influenza virus. The immune system recognises the influenza virus as an external threat. Which of the following best describes the influenza virus in this scenario?

A. Pathogen

B. Allergen

C. Antigen

D. Self

Question 3 (1 mark)

During an allergic reaction to pollen, the immune system overreacts to a harmless substance. Which of the following terms best describes pollen in this context?

A. Antigen

B. Pathogen

C. Self

D. Allergen

Question 4 (1 mark)

A body cell presents a foreign protein fragment on its surface that triggers an immune response. What does the immune system recognise in this case?

A. Antibody

B. Self

C. Antigen

D. Receptor

Question 5 (1 mark)

Which of the following is true about the immune system's ability to distinguish between self and non-self?

A. The immune system always recognises self as foreign.

B. Non-self molecules are typically recognised as threats.

C. Self molecules can trigger allergic reactions.

D. The immune system does not respond to non-self pathogens.

Question 6 (1 mark)

Which of the following is a characteristic feature distinguishing non-cellular pathogens from cellular pathogens?

A. Non-cellular pathogens lack nucleic acids.

B. Non-cellular pathogens cannot replicate independently.

C. Non-cellular pathogens are always larger than cellular pathogens.

D. Non-cellular pathogens do not elicit immune responses.

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Question 7 (2 marks)

Prions are misfolded proteins that induce normal proteins in the brain to adopt abnormal conformations, leading to neuronal damage and neurodegenerative diseases. Unlike other pathogens, prions lack nucleic acids and are composed solely of protein.

Based on their structure and replication method, how should prions be classified: as cellular or non-cellular pathogens? Justify.

Non-cellular, cannot replicate independently like cellular pathogens.

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Sub-Section [3.1.2]: Differentiate between the Two Types of Major Histocompatibility Complex Proteins displayed on Cells, and Explain their Significance

Question 8

Define the following.

a. MHC1 Markers:

Display fragments of proteins synthesised within the cell, allowing immune surveillance for infected or abnormal cells. Allow for self and non-self-cells to be distinguished.

b. MHC II Markers:

Presented on specialised immune cells, used for antigen presentation.

Question 9 (1 mark)

Which of the following statements accurately describes MHC Class I molecules?

A. They are expressed exclusively on antigen-presenting cells (APCs).

B. They present antigens to T-helper cells.

C. They are found on all nucleated cells and play a role in distinguishing self from non-self.

D. They are absent from platelets.

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Question 10 (1 mark)

MHC Class II molecules are primarily found on which of the following cell types?

A. Erythrocytes.

B. Neurons.

C. Antigen-presenting cells.

D. All nucleated cells.

Question 11 (1 mark)

Which of the following statements is true regarding the expression of MHC Class I molecules?

A. MHC Class I molecules are present on all nucleated cells, including red blood cells.

B. Mature red blood cells lack MHC Class I molecules due to the absence of a nucleus.

C. Only antigen-presenting cells express MHC Class I molecules.

D. MHC Class I molecules are found exclusively on platelets.

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Question 12 (6 marks)

a. Explain the role of MHC class I molecules in the immune system and identify which cells are primarily involved in presenting antigens via MHC class I. (2 marks)

- Present antigens that help immune cells recognise cells as "self".
- Displayed on the surface of all nucleated cells (e.g., infected or abnormal cells).

b. In the context of autoimmune disorders, how might the malfunction or mispression of MHC class molecules contribute to the immune system, attacking the body's own cells? For example, in type 1 diabetes, immune cells attack beta cells in the pancreas. (2 marks)

MHC Class I malfunction: Can lead to improper presentation of self-antigens or failure to display foreign antigens, resulting in immune system attacking normal cells.

Example: Type 1 diabetes:
- The immune system attacks the insulin-producing beta cells in the pancreas.

c. A student argues that MHC class I molecules are responsible for the incompatibility of blood transfusions between people of different blood types. Is this student correct? Explain why or why not. (2 marks)

No, the student is not correct.
MHC class I molecules are not responsible for the incompatibility of blood transfusions between different blood types. Blood type incompatibility is caused by the presence of antigens on the surface of red blood cells (e.g., A, B, and Rh antigens), not by MHC molecules (that only exist on enucleated cells).

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Sub-Section [3.1.3]: Identify & Describe the Pathogens Assessed in VCE - Bacteria, Fungi, Protists, Parasites, Viruses, & Prions - Including How they cause Disease

Question 13

Define the following.

a. Bacteria:

Single-celled microorganisms that can thrive in various environments. How They Cause Disease: Release toxins or invade host tissues, causing damage. Examples: Tuberculosis, strep throat.

b. Fungi:

Eukaryotic organisms, including yeasts and molds. How They Cause Disease: Invade tissues or release spores that cause infections, especially in immunocompromised individuals. Examples: Athlete's foot, candidiasis.

c. Protists:

Single-celled eukaryotes, often parasitic. How They Cause Disease: Spread through contaminated water or food, infecting host cells. Examples: Malaria, giardiasis.

d. Parasites:

Organisms that live in or on a host and benefit at the host's expense. How They Cause Disease: Cause damage through nutrient extraction or tissue invasion. Examples: Tapeworms, lice.

e. Viruses:

Non-living infectious agents that require a host cell to replicate. How They Cause Disease: Hijack host cell machinery to reproduce, damaging or killing cells. Examples: Influenza, HIV.

f. Prions:

Infectious proteins that cause misfolding of normal proteins. How They Cause Disease: Accumulate in tissues, causing damage to the brain and nervous system. Examples: Mad cow disease, Creutzfeldt-Jakob disease.

Question 14 (1 mark)

Which of the following characteristics is common to both viruses and prions?

A. They both have a complex cellular structure.

B. They can replicate independently of a host cell.

C. They are both non-living.

D. They can be treated with antibiotics.

Question 15 (1 mark)

Which of the following pathogens is characterised by being eukaryotic and often parasitic, but not typically classified as fungi or bacteria?

A. Bacteria

B. Protists

C. Viruses

D. Prions

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Question 16 (1 mark)

A 45-year-old man is experiencing memory loss, difficulty with balance, and a lack of coordination. He has been progressively getting worse over the past few months. His medical history includes a history of consuming beef from cattle that were raised in areas with poor agricultural practices. Brain scans show spongy tissue in certain areas of his brain.

Which pathogen is most likely responsible for this patient's condition?

A. Virus

B. Prion

C. Fungus

D. Bacteria

Question 17 (1 mark)

What is the role of the viral genome in the viral structure?

A. To produce energy for the virus.

B. To store the instructions for making new virus particles.

C. To protect the host cell from infection.

D. To help the virus evade the immune system.

Question 18 (1 mark)

Which of the following components is found in all viruses?

A. Nucleus

B. Ribosomes

C. Protein coat (capsid)

D. Mitochondria

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Question 19 (1 mark)

Which of the following best describes the capsid of a virus?

A. A protein layer that surrounds and protects the viral genome.

B. A lipid layer that surrounds the virus and helps it infect host cells.

C. A network of enzymes required for viral replication.

D. A structure responsible for energy production within the virus.

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Sub-Section [3.1.4]: Identify & Describe the Physical, Chemical, Microbiological Barriers to Infection present in both Animals & Plants

Question 20

Define the following.

Animals

a. Physical Barriers:

i. Skin:

Acts as a tough, impermeable barrier that prevents pathogens from entering the body.

ii. Mucous Membranes:

Found in the respiratory, digestive, and urogenital tracts. The mucus traps pathogens, preventing them from reaching sensitive tissues.

iii. Cilia:

Hair-like structures in the respiratory tract that move mucus and trapped pathogens out of the airways.

b. Chemical Barriers:

i. Acidic pH:

The stomach acid (pH 1.5-3.5) kills many ingested pathogens.

ii. Lysozyme:

An enzyme found in saliva, tears, and mucus that breaks down the cell walls of bacteria.

iii. Antimicrobial Peptides:

Small proteins that disrupt the cell membranes of pathogens, found in skin, mucous membranes, and other tissues.

c. Microbiological Barriers:

Normal Flora (Microbiota):

The beneficial microorganisms that reside in various parts of the body (e.g., gut, skin). They compete with pathogenic microorganisms for space and nutrients, inhibiting their growth.

Plants

d. Physical Barriers:

i. Cell Wall:

A rigid outer layer of plant cells that provides physical protection against pathogen entry.

ii. Cuticle:

A waxy layer covering the leaves and stems that prevents water loss and serves as a barrier to pathogen invasion.

iii. Trichomes:

Hair-like structures on plant surfaces that physically block pathogens or release toxins to deter them.

Question 21 (1 mark)

A researcher investigates the role of physical barriers in protecting an animal from infection. The animal is exposed to a pathogen, but no infection occurs due to an intact layer of tissue preventing pathogen entry. Which of the following is most likely the barrier responsible for preventing the infection?

A. Cilia in the respiratory system.

B. Normal microbiota in the intestines.

C. The skin's keratinised epithelial cells.

D. The stomach's acidic pH.

c) The skin's keratinised epithelial cells.
(The skin serves as a physical barrier to pathogens by providing a tough, impermeable layer that prevents entry.)

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Question 22 (1 mark)

In a controlled experiment, a plant is exposed to a fungal pathogen. The plant produces a compound that inhibits the growth of the pathogen. Which of the following best describes the type of barrier being activated in the plant?

A. Physical barrier

B. Chemical barrier

C. Microbiological barrier

D. None of the above.

b) Chemical barrier.
(The plant's production of a chemical that inhibits pathogen growth represents a chemical defence mechanism.)

Question 23 (1 mark)

A plant exhibits wilting and yellowing of leaves after being exposed to a bacterial infection. The plant increases the production of a protein that blocks bacterial enzymes and inhibits the pathogen. Which of the following explains the plant's response?

A. The plant is activating a microbiological barrier by increasing its normal flora.

B. The plant is increasing its chemical barriers through protein production.

C. The plant is using a physical

D. The plant is activating an im

b) The plant is increasing its chemical barriers through protein production.
(The plant's response to produce proteins that block bacterial enzymes is an example of a chemical defence.)

Question 24 (1 mark)

A scientist is studying the effect of normal microbiota in preventing infection in an animal model. The model is exposed to a harmful pathogen, but infection does not occur due to the presence of beneficial microorganisms in the gut. Which barrier is primarily responsible for this defence?

A. Physical barrier

B. Microbiological barrier

C. Chemical barrier

D. Immune response

b) Microbiological barrier.
(The normal microbiota competes with pathogens for resources and space, preventing infection—this is a microbiological barrier.)

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Question 25 (1 mark)

After being exposed to a harmful pathogen, a plant rapidly develops a waxy coating on its leaves, which prevents further pathogen spread. Which of the following best describes this plant's response?

A. It has activated a chemical barrier to stop the infection.

B. It has enhanced its physical barrier to prevent further pathogen invasion.

C. The plant is increasing its m

D. It is signalling an immune r

b) It has enhanced its physical barrier to prevent further pathogen invasion. (The waxy coating on the leaves serves as a physical barrier that blocks pathogen entry.)

Question 26 (1 mark)

Cilia and mucus work together in the respiratory system to prevent infection. Which of the following best describes how cilia and mucus function together to protect the body?

A. Cilia trap pathogens in mucus and expel them through coughing or sneezing.

B. Mucus destroys pathogens by producing enzymes that break down their cell walls.

C. Cilia increase mucus

D. Mucus prevents path

a) Cilia trap pathogens in mucus and expel them through coughing or sneezing. (Cilia move mucus that traps pathogens out of the respiratory tract, helping to prevent infection.)

Question 27 (1 mark)

A researcher is studying the role of tears and saliva in preventing infection. Which of the following is the most likely function of these bodily fluids in protecting against pathogens?

A. Tears and saliva contain lysozyme, which breaks down bacterial cell walls.

B. They act as physical barriers to prevent pathogens from entering the body.

C. Tears and saliva create a sticky surface that traps pathogens, preventing them from spreading.

D. They contain antibodies that specifically target and destroy viral pathogens.

a) Tears and saliva contain lysozyme, which breaks down bacterial cell walls. (Tears and saliva contain lysozyme, an enzyme that breaks down bacterial cell walls and helps prevent infection.)

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Question 28 (1 mark)

A scientist studies a plant that produces trichomes with a sticky secretion on its leaves. Which of the following is the most likely defence mechanism these trichomes provide against pathogens?

A. They kill pathogens by directly injecting toxins.

B. They trap and immobilise pathogens, preventing them from reaching plant tissues.

C. They produce antimic

D. They secrete a chemic

b) They trap and immobilise pathogens, preventing them from reaching plant tissues. (Trichomes can physically block pathogens and prevent them from penetrating plant surfaces.)

Question 29 (2 marks)

A patient presents with frequent skin infections. Identify and explain the role of two physical barriers in animals that could be compromised in this case.

- **Skin (epidermis):**
  - Acts as a tough, impermeable barrier to pathogens, preventing them from entering the body.
  - Infections may occur if the skin is damaged or compromised (e.g., cuts, eczema), allowing pathogens to breach the barrier.
- **Mucous Membranes:**
  - Found in the respiratory, digestive, and urogenital tracts, they trap pathogens in sticky mucus.
  - Damage or inflammation (e.g., from allergies or infections) may reduce mucus production, making the body more vulnerable to infections.

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Question 30 (5 marks)

a. A scientist introduces a pathogen into the gastrointestinal tract of an animal. The pathogen fails to establish an infection despite the presence of the pathogen in the gut. Which chemical barrier is likely responsible for this outcome, and how does it act to prevent infection? (3 marks)

- **Stomach Acid (Hydrochloric Acid)**:
  - The acidic environment in the stomach (pH 1.5-3.5) kills many pathogens by denaturing proteins and disrupting their cellular structures.
  - This chemical barrier helps prevent the establishment of infections in the gastrointestinal tract by destroying ingested pathogens before they can cause harm.

b. In a controlled experiment, a plant's natural microbiota is removed. Explain how this could affect the plant's ability to resist pathogen invasion and describe one strategy the plant might use to compensate for the loss of microbiological protection. (2 marks)

- The removal of natural microbiota can impair the plant's defence mechanisms, as beneficial microbes play a role in protecting the plant by outcompeting pathogens and enhancing immune responses.
- **Compensation:** The plant could increase its production of antimicrobial chemicals like phytoalexins or bolster its physical defences, such as thickening the cuticle or increasing trichome production, to limit pathogen entry.

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