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VCE Biology ¾
The Innate Immune System [3.2]
Homework Solutions

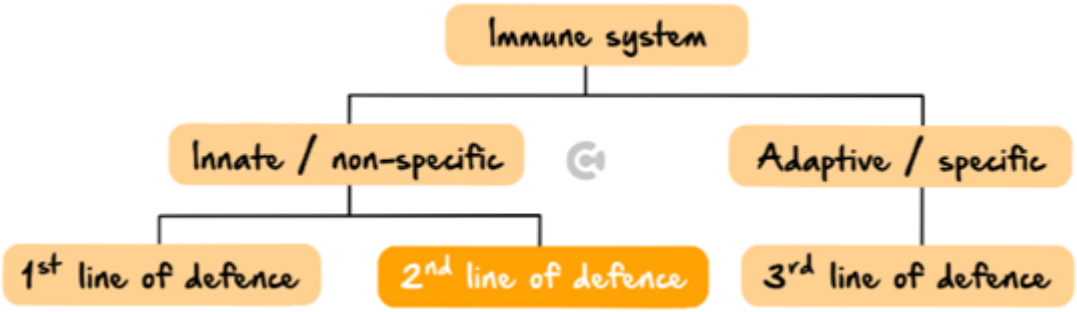
Admin Info & Homework Outline:

Student Name	
Questions You Need Help For	
Homework Questions	Pg 2-Pg 20

Section A: Homework Questions (50 Marks)

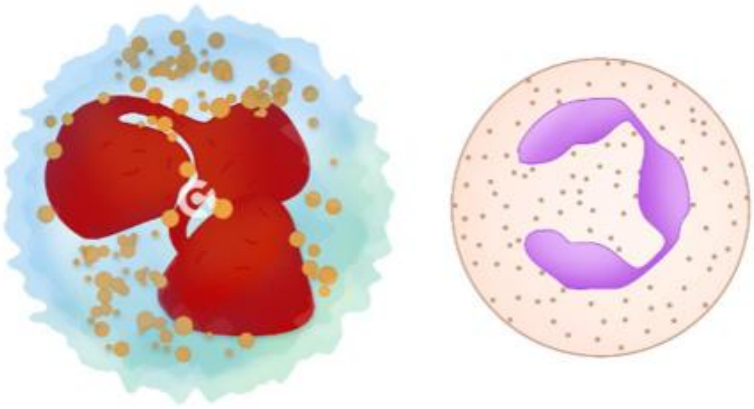
Overview

- The innate immune system is the first layer of defense against pathogens.
  - Barriers prevent the entry of the pathogen; this lesson will focus on what occurs next.
- The innate immune system is ___non-specific___ and delivers a ___fast___ response to any pathogens that make it through to the intracellular space.



Neutrophils

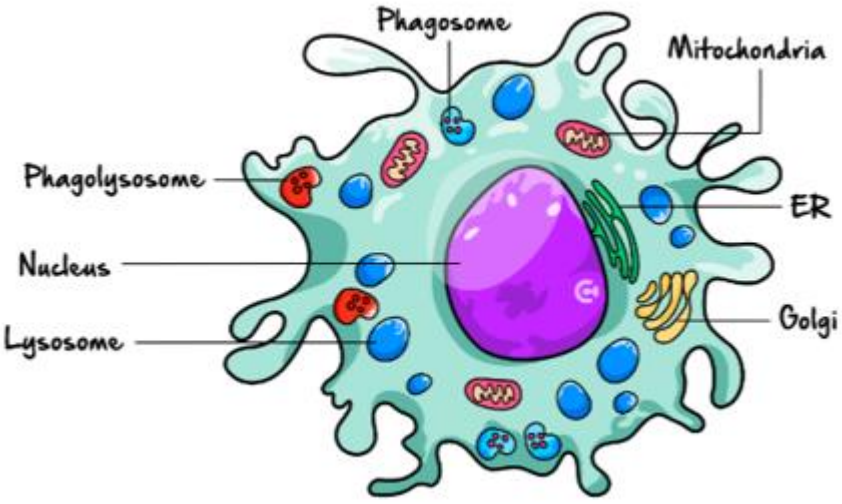
- They are classed as a phagocyte - ___they will engulf pathogens to eliminate them___.
  - The vast majority of the immune cells in your body are neutrophils - ___50-60%___.
- First responders, but also are very expendable.
- Common component of pus.



3D rendering of a neutrophil

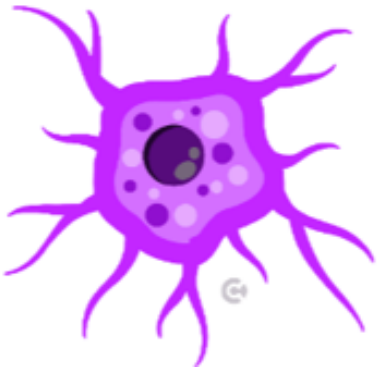
Macrophages

- These are larger immune cells - also _____ phagocytes _____.
  - Broader range of function and longer lived than compared to neutrophils.
  - Can be found as a permanent part of some tissues.
  - Can also release cytokines to induce other responses of the immune system.
- Involved with antigen presentation.



Dendritic Cells

- Another cell that engages in phagocytosis, primarily found in tissues, but can travel through the bloodstream.
  - More specialised for the process of antigen presentation. Why?



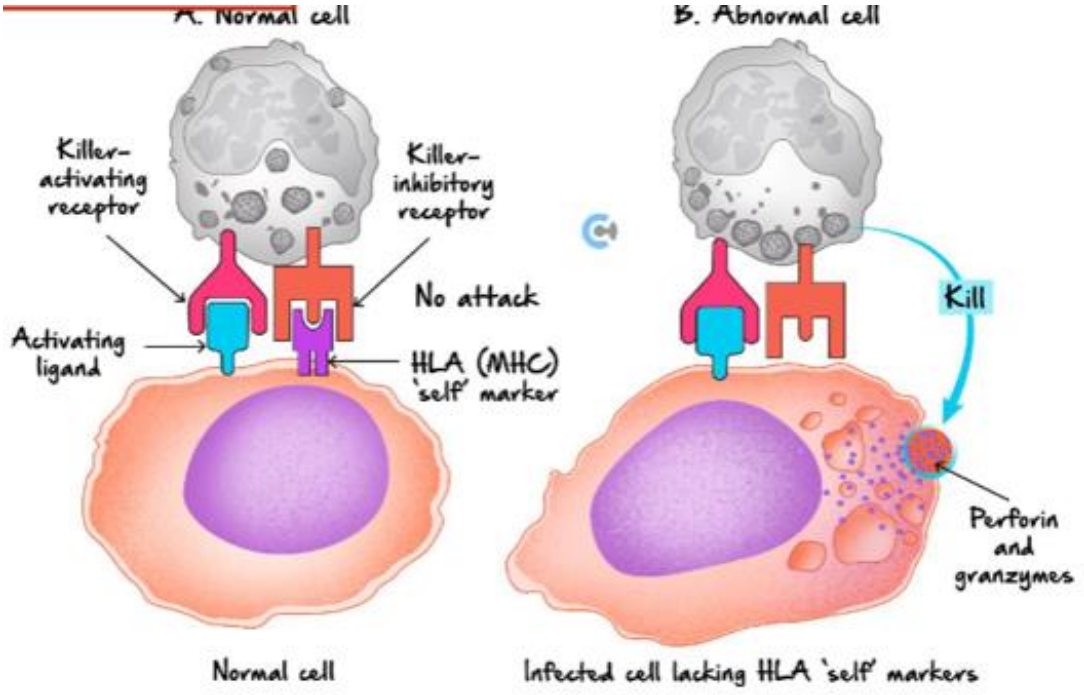
Natural Killer Cells

- These are cells that do not target foreign cells but actually focus on targeting your own unhealthy cells, or infected cells.
  - Why might cells be unhealthy?

    Cancer
  - How could the unhealthy cell be recognised?

    Inhibitory and activatory receptors including for MHC markers, abnormal, or missing.

- This natural killer cell will then release perforins and granzymes which will trigger the cell's death by ——— inducing apoptosis ———.



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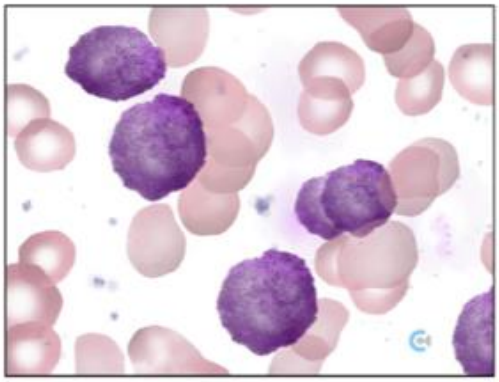
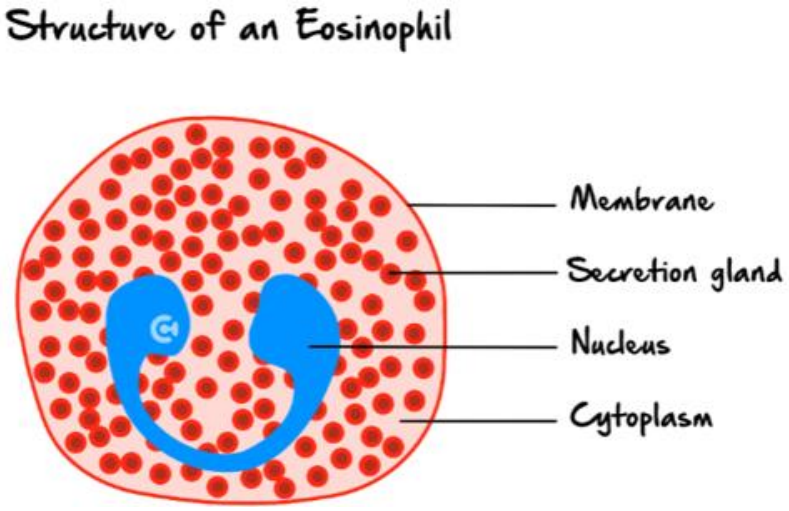
Mast Cells

- Immune cell that is primarily responsible for the release of _____histamine_____ and other mediators that activate the immune system.
  - Not directly involved in the defense but rather stimulates other cells to do so - releases other kinds of cytokines as well.
- Remains in tissue.



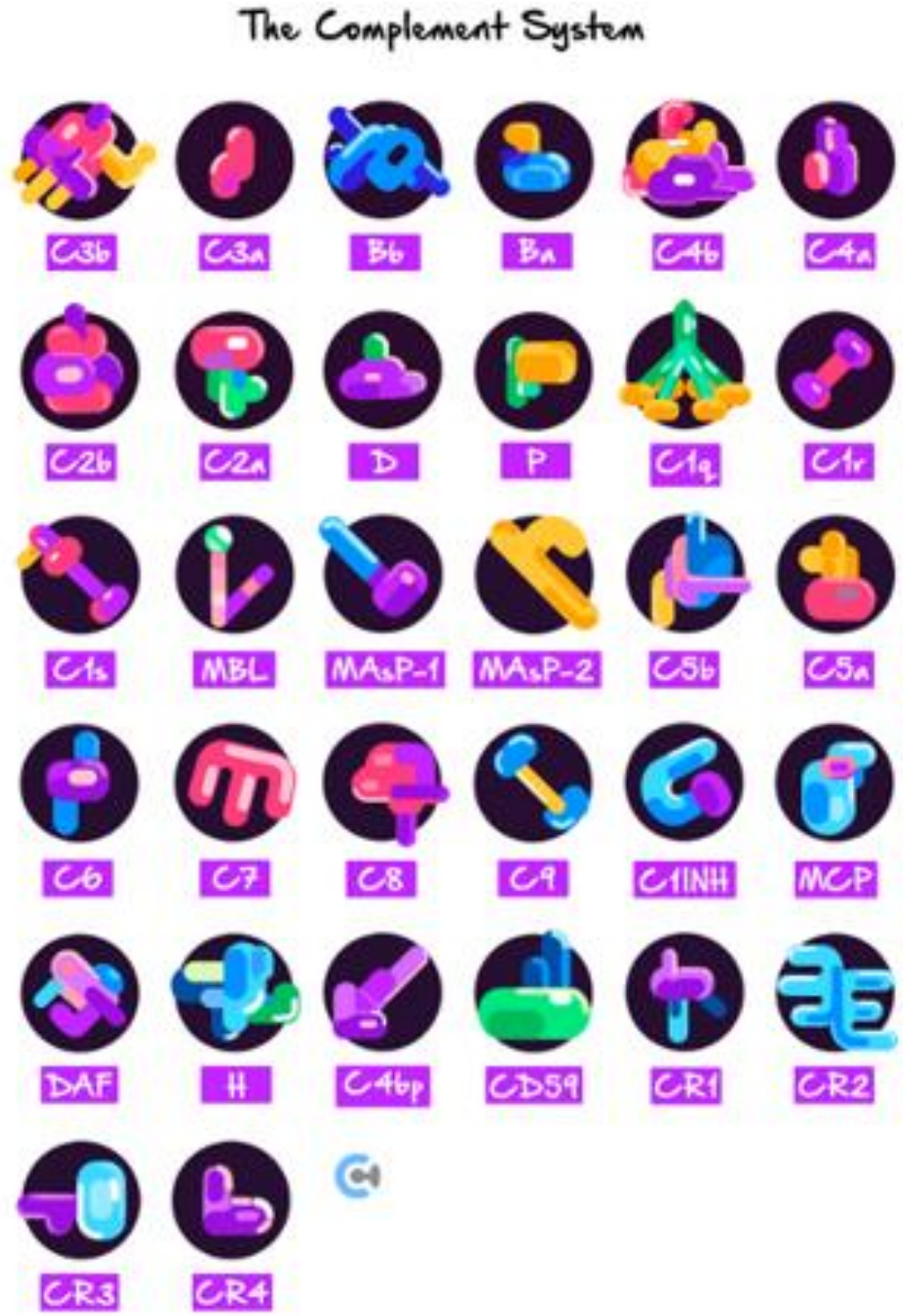
Eosinophils

- Immune cells which release _____toxic chemical mediators_____ - impacting pathogens which cannot be ingested fully via phagocytosis.
  - Able to phagocytose, but to a very limited extent.
- Degranulate upon contact - what process would we call this ordinarily?



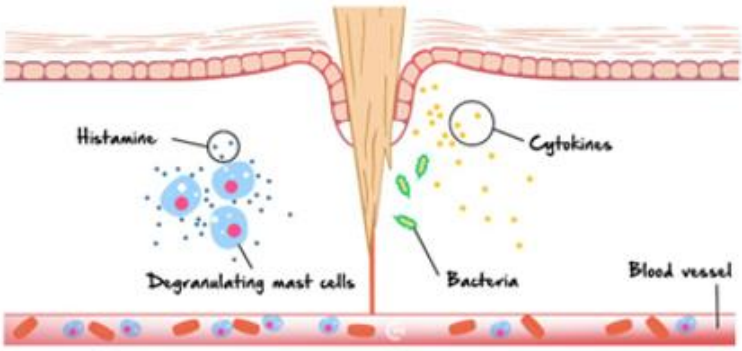
The Complement System

- The complement system is a set of proteins that float around the body in the blood, and act as an innate defense against pathogens.
  - Primarily focused against bacteria.

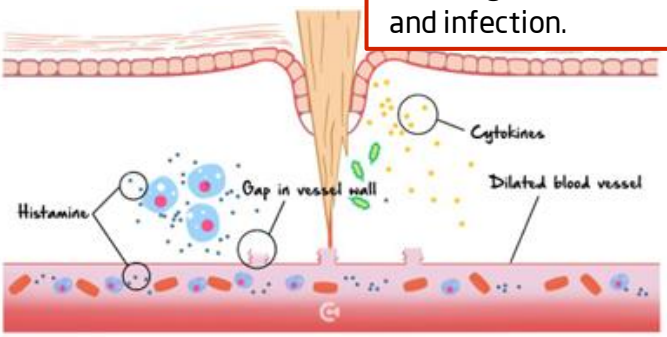


Overview of the inflammatory Response

- The inflammatory response is an innate response to pathogenic infection and injury, which serves to rapidly shut down further infections and damage by increasing blood flow to an affected tissue.
  - There are three main aspects to it - ___initiation, vasodilation, and migration___.
- Classic example is a splinter.
- *Initiation* - When the splinter pierces the protective layer of the skin, it damages skin cells and ___introduces the pathogens that___ may have been present in the splinter to the body. Damaged cells release cytokines, mast cells degranulate releasing ___histamine___.



- *Vasodilation* - ___Histamine___ travels from t
  to specific receptors which trigger vasodilation - ___widening the blood vessels and increasing the blood flow___.
  The permeability of the vessel wall also increases - ___allowing blood to reach the site of damage and infection.___



Histamine has caught the blood vessel to dilate and become 'leaky'.

Fever

- Increasing central body temperature - to disrupt the function of pathogens. How?
  - Can fevers be bad for us too?

Sub-Section [3.2.1]: Explain How the Innate Response is Triggered in Response to Infection & its Defining Characteristics

Question 1 (1 mark)

Which of the following is a key feature of the inflammatory response?

A. Increased blood flow and capillary permeability.

B. Immediate antibody production.

C. Clonal selection of T lymphocytes.

D. Suppression of immune cell activity.

Question 2 (1 mark)

What is the role of complement proteins in the innate immune response?

A. They stimulate the production of antibodies.

B. They enhance phagocytosis, induce inflammation, and form membrane attack complexes.

C. They recognise specific antigens on pathogens.

D. They produce cytokines for long-term immunity.

Question 3 (1 mark)

How do natural killer (NK) cells contribute to the innate immune response?

A. By engulfing pathogens.

B. By recognising and destroying virus-infected or cancerous cells.

C. By producing antigen-specific antibodies.

D. By presenting antigens to T cells.

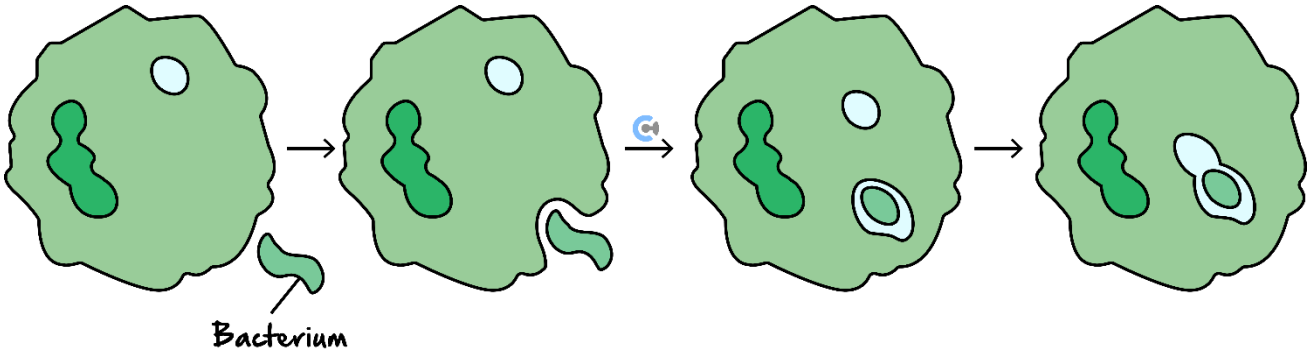
Question 4 (2 marks)

Why is the innate immune response considered non-specific?

Innate immunity recognises general patterns on pathogens rather than specific antigens. (1 mark)
It responds similarly to all types of infections, without forming memory. (1 mark)

Question 5 (3 marks)

Describe the significance of the process given in the diagram.



Macrophages contribute to the innate immune response by performing phagocytosis, where they engulf and digest pathogens, cellular debris, and foreign particles. This process helps eliminate infectious agents before they can spread further in the body. (1 mark)

Macrophages secrete cytokines and chemokines, which act as signalling molecules to recruit other immune cells to the site of infection. These chemical messengers enhance the inflammatory response and promote faster clearance of pathogens. (1 mark)

Macrophages function as antigen-presenting cells by displaying fragments of digested pathogens on their surface using major histocompatibility complex (MHC) molecules. This antigen presentation is crucial for activating *T* cells, linking the innate and adaptive immune responses. (1 mark)

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Sub-Section [3.2.2]: Identify & Describe the Function of the Cellular Components of the Innate Immune Response - Macrophages, Neutrophils, Dendritic Cells, Mast Cells, Eosinophils

Question 6 (1 mark)

Which cell type is particularly specialised in combating parasitic infections and modulating allergic responses?

A. Neutrophils

B. Dendritic cells

C. Macrophages

D. Eosinophils

Question 7 (1 mark)

Which of the following is a primary function of macrophages in the innate immune response?

A. Producing antibodies.

B. Phagocytosis and antigen presentation.

C. Releasing histamine.

D. Generating active oxygen species exclusively.

Question 8 (1 mark)

What role do neutrophils play at the onset of an infection?

A. They synthesise antibodies.

B. They directly present antigens to T cells.

C. They rapidly migrate to the infection site and perform phagocytosis.

D. They secrete cytokines exclusively for adaptive immunity.

Question 9 (2 marks)

In what manner do dendritic cells bridge innate and adaptive immunity?

Dendritic cells capture and process antigens from pathogens and subsequently travel to lymph nodes. (1 mark)
In the lymph nodes, dendritic cells present these antigens to T cells, thereby triggering a specific adaptive immune response. (1 mark)

Question 10 (3 marks)

Discuss the importance of antigen presentation by macrophages and dendritic cells in the context of innate immunity.

Antigen presentation by macrophages involves the processing of ingested pathogens and displaying antigen fragments on the cell surface using MHC molecules, which is essential for the activation of T cells. (1 mark)
Dendritic cells further enhance this process by capturing antigens at the site of infection and migrating to lymph nodes to present them to T cells, thereby initiating the adaptive immune response. (1 mark)
This mechanism is crucial for bridging innate immunity with adaptive immunity and ensuring a targeted and effective immune response. (1 mark)

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Sub-Section [3.2.3]: Identify & Describe the Role of Non-Cellular Components of the Innate Immune Response – Complement Proteins & Interferons

Question 11 (1 mark)

Which of the following is an example of a non-cellular component of the innate immune response?

A. Macrophages

B. Neutrophils

C. Complement proteins

D. Dendritic cells

Question 12 (1 mark)

Which non-cellular component is primarily responsible for inhibiting viral replication?

A. Complement proteins

B. Antibodies

C. Interferons

D. Cytokines

Question 13 (1 mark)

How do interferons primarily protect neighbouring cells during a viral infection?

A. They promote phagocytosis by neutrophils.

B. They inhibit viral replication by inducing an antiviral state in neighbouring cells.

C. They directly lyse infected cells.

D. They facilitate antigen presentation by dendritic cells.

Question 14 (2 marks)

What are interferons, and how do they contribute to antiviral defense?

Interferons are a group of cytokines produced by host cells in response to viral infection. (1 mark)
They contribute to antiviral defense by binding to receptors on neighbouring cells, inducing an antiviral state that inhibits viral replication and spread. (1 mark)

Question 15 (3 marks)

Discuss the roles of complement proteins in the innate immune response and explain how they contribute to pathogen elimination.

Complement proteins contribute to the innate immune response by initiating a cascade that results in the opsonisation of pathogens, which marks them for enhanced phagocytosis by immune cells. (1 mark)
Additionally, these proteins generate chemotactic signals that recruit immune cells to the infection site and form the membrane attack complex, which directly lyses pathogenic cells. (1 mark)
These combined functions are crucial for the rapid elimination of pathogens from the host. (1 mark)

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Sub-Section [3.2.4]: Describe Key Innate Immune Processes – Phagocytosis, Inflammatory Response

Question 16 (1 mark)

Which of the following best characterises the inflammatory response?

A. A highly specific adaptive process.

B. A rapid, non-specific response that increases blood flow and immune cell recruitment.

C. A mechanism that relies solely on antibodies.

D. A process that primarily occurs in the lymph nodes.

Question 17 (1 mark)

What is the role of macrophages in the process of phagocytosis?

A. They produce antibodies to mark pathogens.

B. They engulf and digest pathogens and cellular debris.

C. They secrete histamine.

D. They form a physical barrier.

Question 18 (1 mark)

Which mediator is primarily responsible for increasing vascular permeability during inflammation?

A. Interferon

B. Histamine

C. Complement protein C3

D. Interleukin-2

Question 19 (2 marks)

How does histamine contribute to the inflammatory response?

Histamine is released by mast cells and contributes to the inflammatory response by increasing the permeability of blood vessels. (1 mark)

This increased permeability facilitates the migration of immune cells to the site of infection. (1 mark)

Question 20 (3 marks)

A student accidentally scrapes their knee while playing sport. A few minutes later, the area around the injury becomes red, swollen, and warm.

Describe two key innate immune processes that occur at the site of injury and explain how each process helps prevent the entry or spread of pathogens.

The inflammatory response occurs when mast cells at the site release histamine, causing blood vessels to dilate and become more permeable. (1 mark)
This allows more phagocytes and plasma to move into the tissue, helping to eliminate pathogens. (1 mark)
Phagocytosis occurs when phagocytes such as neutrophils or macrophages engulf and digest invading pathogens using enzymes, helping to remove them before they can spread. (1 mark)

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Sub-Section [3.2.5]: Apply Knowledge of Innate Immune Response to Unfamiliar Contexts Such as Pathogen Infection

Question 21 (1 mark)

A person inhales fungal spores while gardening. Within hours, alveolar macrophages begin engulfing the spores. This response is best described as:

A. A specific immune response involving antibodies.

B. An innate immune response involving phagocytosis.

C. A cell-mediated adaptive response.

D. A humoral response involving T helper cells.

Question 22 (1 mark)

A virus infects a person's skin cells. Nearby natural killer (NK) cells detect and destroy the infected cells. This activity helps limit the spread of the virus by:

A. Producing memory cells specific to the virus.

B. Releasing antibodies to neutralise the virus.

C. Inducing apoptosis in the infected cells.

D. Engulfing viral particles directly.

Question 23 (1 mark)

A bee sting causes redness, swelling, and warmth in the affected area. These signs are due to the release of histamine from:

A. Neutrophils.

B. B cells.

C. Mast cells.

D. Cytotoxic T cells.

Question 24 (1 mark)

In a bacterial infection, neutrophils are among the first cells to arrive at the site of infection. Their main function in the innate immune response is to:

A. Present antigens to T cells.

B. Produce specific antibodies against bacteria.

C. Engulf and digest bacterial cells.

D. Activate memory B cells.

Question 25 (2 marks)

A researcher observes that mice lacking neutrophils are more susceptible to bacterial infections than normal mice. Explain why neutrophils are important in the innate immune response against bacteria.

Neutrophils are phagocytic cells that engulf and digest bacteria using enzymes. (1 mark) Without them, the body cannot rapidly eliminate invading bacteria, increasing the risk of infection. (1 mark)

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Question 26 (3 marks)

A student steps on a rusty nail, introducing bacteria deep into the skin tissue. Soon after, redness, heat, and swelling occur around the wound.

a. Name the immune process responsible for these symptoms. (1 mark)

The inflammatory response.

b. Explain how this process supports the action of phagocytes in eliminating the bacteria. (2 marks)

Inflammation causes vasodilation and increased capillary permeability, allowing phagocytes such as neutrophils and macrophages to move from the bloodstream into the tissue. (1 mark)
This helps them reach the site of infection and destroy bacteria through phagocytosis. (1 mark)

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Sub-Section [3.2.6]: Explain the Symptoms Associated With the Inflammatory Response

Question 27 (1 mark)

Which of the following is not a typical symptom of the inflammatory response?

A. Redness

B. Swelling

C. Fever

D. Memory cell formation

Question 28 (1 mark)

The redness and warmth observed at the site of inflammation are primarily due to:

A. Activation of cytotoxic T cells.

B. Increased blood flow to the area.

C. Antibody production.

D. Phagocytosis of pathogens.

Question 29 (1 mark)

Swelling at the site of injury during inflammation is mostly caused by:

A. Increased phagocyte division.

B. Fluid and plasma leaking into tissues.

C. Lymphocyte migration.

D. Decreased capillary permeability.

Question 30 (1 mark)

Pain during inflammation is a result of:

A. Antibodies binding to receptors.

B. Interference with adaptive immunity.

C. Chemical signals stimulating nearby nerve endings.

D. Increased oxygen in the tissue.

Question 31 (2 marks)

Describe two symptoms of the inflammatory response and explain the physiological reason for each.

Redness occurs due to increased blood flow from vasodilation. (1 mark)

Swelling results from fluid leaking out of blood vessels into surrounding tissue due to increased capillary permeability. (1 mark)

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Question 32 (3 marks)

A student grazes their knee during a fall. Shortly after, the area becomes red, swollen, and painful.

Describe the immune process responsible for these symptoms and explain how two of these symptoms assist in defending the body against infection.

The inflammatory response is responsible for these symptoms. (1 mark)
Redness occurs due to vasodilation, which increases blood flow and delivers more immune cells to the site of injury. (1 mark)
Swelling is caused by increased capillary permeability, allowing phagocytes and plasma to move into the tissue, where phagocytes can engulf and destroy pathogens, helping prevent infection. (1 mark)

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