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VCE Biology ¾ Lymphatics & Adaptive Immunity (Humoral) [3.3]

Workbook

Outline:

Pg 3-9

- Understanding the Lymphatic SystemOverview of the Lymphatic System
- Structure of the Lymphatic System

Introduction to Adaptive Immunity Pg 10-16

- Characteristics of the 3rd Line of Defence
- Antigen Presentation

Humoral Immunity

- Activating Humoral Immunity
- Sample Response to Humoral Immunity
- Antibodies
- Case Study

Study Design Key Knowledge:

Study Design: Responding to Antigens

The role of the lymphatic system in the immune response as a transport network and the role of lymph nodes as sites for antigen recognition by B lymphocytes.

The characteristics and roles of the components of the adaptive immune response against extracellular threats, including the actions of B lymphocytes and their antibodies.

https://www.vcaa.vic.edu.au/Documents/vce/biology/2016BiologySD.pdf#page=23



Pg 17-32





Learning Objectives:

□ BI34 [3.3.1] - Identify the Structure of the Lymphatic System, including Primary & Secondary Lymphatic Tissue
BI34 [3.3.2] - Identify the Role of the Lymphatic System in Fighting Infections
BI34 [3.3.3] - Explain Antigen Presentation as a means to initiate the Adaptive Immune Response
BI34 [3.3.4] - Identify the Characteristics of the Adaptive Response which Differentiate it from the Innate Response
□ BI34 [3.3.5] - Identify & Explain the Humoral Response as a Response to Extracellular Pathogens, including the Role of B and T Helper Lymphocytes
□ BI34 [3.3.6] - Explain the Significance of Memory Cells to generate Immunological Memory, & How that prevents Future Infections
BI34 [3.3.7] - Differentiate between Extracellular & Intracellular Threats
BI34 [3.3.8] - Explain how Antibodies are used to Fight against Infections, and Draw their Structure

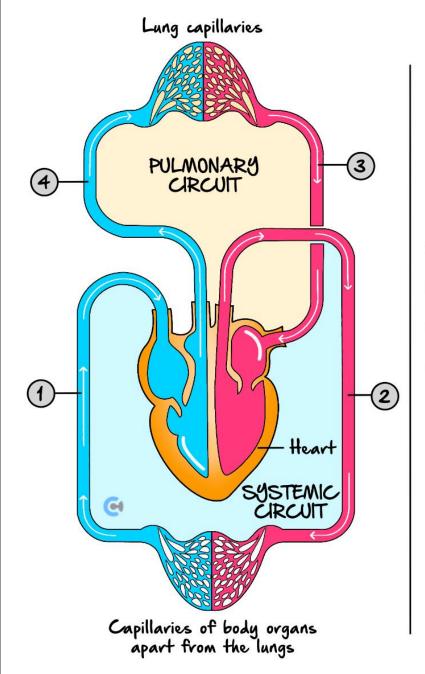


Section A: Understanding the Lymphatic System

Context: The Circulatory System



- Fluid: Understanding movement is essential before learning the lymphatic system.
- Circulatory System: Moves blood and nutrients throughout the body.
- What is responsible for pumping blood around the body? What tubes does blood use to go TOWARDS tissue? How does it come back?



- 1) Vena cava from body
- 2 Aorta to body
- (3) Pulmonary vein to lungs
- 4 Pulmonary artery to lungs



Sub-Section: Overview of the Lymphatic System



Introduction to Lymphatics



acting as a transport system f
immune cells, particularly antigen-presenting cells, whilst also serving other general functions.

- Important roles in the ______ and _____ systems.
- Its main functions include:
 - Transportation of ______ to secondary lymphoid tissues for ______.
 - Production of leukocytes, including ______ in primary lymphoid tissues.
 - Removal and filtration of fluid from tissues around the body.
 - Absorption of fatty acids from the digestive system.
- Very complicated in terms of its function, but we will only be focusing on the immune side!

How does fluid that leaves the circulatory system come back?



<u>Discussion:</u> How does returning this fluid allow the body to maintain a fluid balance?

What would happen if there was no mechanism for this to return?



Analogy



- Your blood vessels act like the city's plumbing system, delivering water (blood) to homes (tissues). But not all the water stays inside the pipes, some leaks out into the streets (the spaces between cells).
- Without a drainage system, these streets would flood.
- That's where the **lymphatic system** comes in: it's the **stormwater drain**, collecting leaked fluid and returning it to the main water supply near the heart.
- This keeps the city (your body) from flooding (swelling), and lets circulation work smoothly.



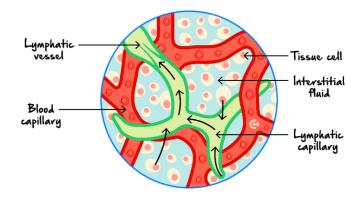
What is lymph?



Lymph



Clear fluid that is drained from the interstitial space!





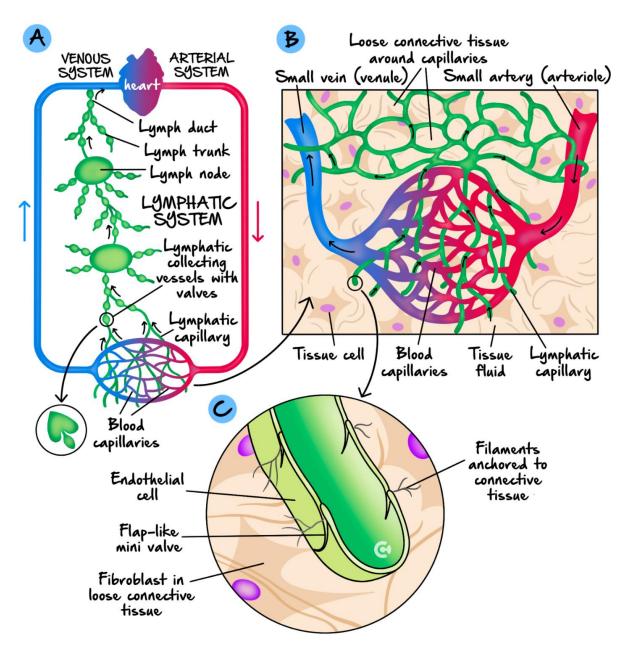
Sub-Section: Structure of the Lymphatic System



Structure of the Lymphatic System



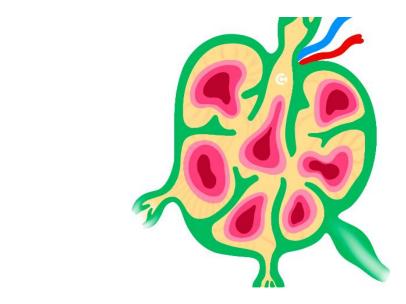
- There are lymphatic vessels that essentially drain lymph from interstitial tissues, where it re-enters circulation via veins near the heart.
 - Lymphatic capillaries will drain lymph from the tissue, these are separate to blood vessels.

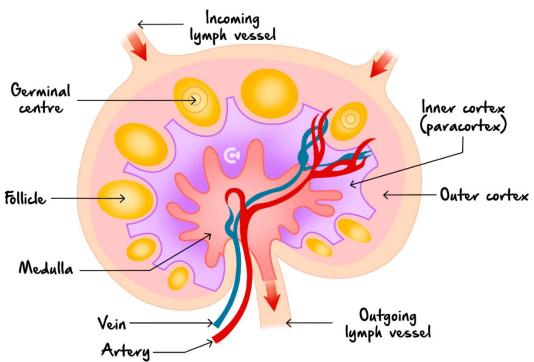


- Lymph vessels all contain one-way valves.
- Muscle contractions help push the lymph towards the heart.

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- As the lymph is collected, it passes through lymph nodes where the main filtration of this fluid occurs, considered to be ______.
 - Large numbers of immune cells will be gathered there, ready to detect and eliminate pathogens, and immune cells draining from the tissue will also present antigens to them, helping to initiate the adaptive immune response!



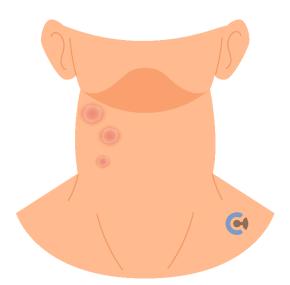




NOTE: The Victorian Curriculum and Assessment Authority (VCAA) traditionally doesn't delve into the granular workings of the lymphatic system. Instead, the focus is laid on its immunological roles, such as being a conduit for antigen-presenting cells and a cradle for the adaptive immune response. This added detail serves as a foundation for understanding the expected knowledge.

Discussion: Why do lymph nodes swell?





<u>Discussion:</u> What is the difference between primary and secondary lymphoid tissue?

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<u>Feature</u>	Primary Lymphoid Tissue	Secondary Lymphoid Tissue
Main Function		
Key Examples		
Involved in Antigen Recognition?		



<u>Discussion:</u> Why is this lymph filtration at the nodes useful?



Key Takeaways



- Understanding the Lymphatic System:
 - The lymphatic system is a secondary circulatory system that transports lymph a clear fluid containing immune cells and waste products.
 - Lymph originates from plasma that leaks out of blood vessels and bathes tissues (interstitial fluid).
 - ☑ It is collected by lymphatic capillaries and returned to circulation near the heart.
 - Maintains tissue fluid balance by draining excess fluid and preventing accumulation.
 - Without drainage, fluid builds up causing swelling (oedema).
 - Lymphatic vessels contain one-way valves and rely on skeletal muscle contractions to move lymph toward the heart.
 - Plays a major role in immune surveillance and defence.
 - ✓ Transports antigen-presenting cells (APCs) like dendritic cells to lymph nodes.
 - ☑ Delivers pathogens or antigens from tissues to immune hubs.
 - Primary lymphoid tissues (bone marrow, thymus) are where lymphocytes are formed and matured.
 - Secondary lymphoid tissues (lymph nodes, spleen) are sites where mature lymphocytes encounter antigens.
 - Lymph nodes filter lymph and concentrate immune cells for rapid detection of pathogens.
 - Lymph nodes swell when many immune cells are activated and proliferating during an infection.



Section B: Introduction to Adaptive Immunity

Sub-Section: Characteristics of the 3rd Line of Defence



What differentiates the 2nd and 3rd lines of defence?

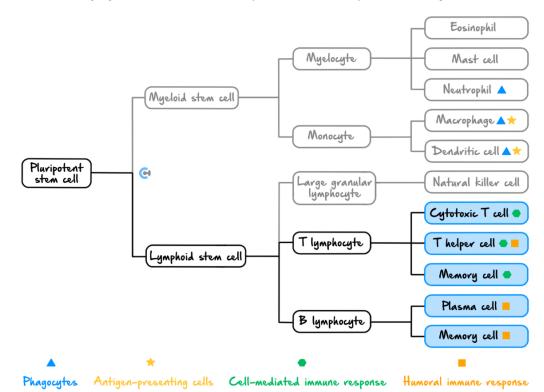


The Third Line of Defence



- Adaptive immunity is the branch of your immune system that mounts a specific, targeted response to invaders, and remembers them for faster defence in the future.
- There are two key features that separate the third line of defence from the second line of defence:
 - **G**
 - **@** _____
- The adaptive immune response primarily engages the use of lymphocytes to facilitate it. These lymphocytes have receptors _____ which allows them to be selected and then cloned.

Highlighted are the cellular components of the adaptive immune system



The adaptive immune response can essentially be targeted to	
threats, and thethreats.	targeted to
tilleats.	
This is facilitated by B cells and T cells, with T help	er cells being involved in both responses.
Active Recall: What is the importance of having a spec	ific response with memory?
What is the difference between intrac	rellular and extracellular pathogens?
П	
<u>Discussion:</u> Extracellular vs Intracellular Pathogens	
Think about the prefixes - 'extra' and 'intra'.	
What pathogens might be examples of each of the	se?
How should we protect against them?	
П	
Space for Personal Notes	



Analogy: The Defence of China feat. Mulan and Mongolians



- Credit to Wayne Tze Wei Tan for this analogy!
- Pathogen: Mongolians (No racism).



▶ 1st line of defence: The wall, serving as a physical barrier to Mongolian invasion.



 $ightharpoonup 2^{
m nd}$ line of defence: The soldiers on the wall, ready to attack anything that they see climb over.



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Antigen presentation: Helpless soldier calls for backup, alerting the rest of China about the threat.



> 3rd line of defence: Training up Mulan so she can beat the Mongolians up.



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Sub-Section: Antigen Presentation



How does the 3rd line know when to act?

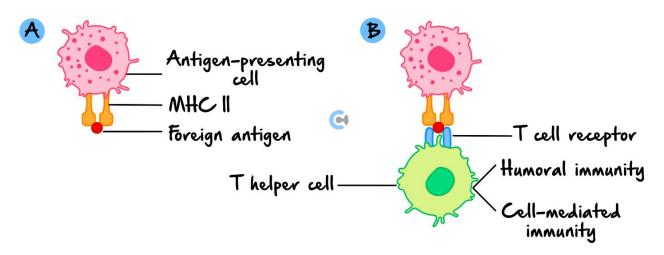


How can it be specific to antigens?



Antigen Presentation

- Antigen presentation is the process where ______ (APCs) display fragments of a foreign pathogen on their MHC ______ molecules.
- This allows **specific helper T lymphocytes** to recognise the antigen and activate the **adaptive (third line) immune response**.



- A An antigen-presenting cell displaying a foreign antigen via MHC II.
- B An antigen-presenting cell presenting an antigen to a complementary T cell receptor on a T helper cell, consequently activating it.





Analogy: Cinderella's Glass Slipper



- Finding the matching receptor is a lot like Cinderella finding her matching slipper!
- Has to be a complementary fit between antigen and receptor to generate a SPECIFIC response!



Only the lymphocyte with the exact matching receptor can bind to the antigen. Just like only Cinderella's foot fits the slipper, only the 'right' cell fits the antigen—and gets selected.

Key Takeaways: Introduction to Adaptive Immunity



- The adaptive immune system is the body's third line of defence, acting with precision and long-term memory.
- ▼ Two hallmark features distinguish it from the innate immune system:
 - Specificity: Each immune cell targets a unique antigen.
 - Memory: Once exposed, the immune system "remembers" the antigen and responds faster next time.
- Adaptive immunity includes two major responses:
 - Humoral immunity: B cells produce antibodies targeting extracellular pathogens (e.g., bacteria, viruses in blood).
 - Cell-mediated immunity: T cells eliminate intracellular pathogens (e.g., viruses inside host cells).
- ☑ Activation depends on specific binding between antigens and lymphocyte receptors.
 - Lymphocytes with receptors matching the presented antigen are selected and activated.
- Helper T cells (Th cells) are central to coordination.
 - They activate both B cells and cytotoxic T cells by releasing cytokines.



V	Antigen	presentation	is key to	triggering	adantive	immunity
Y	MILISCII	presentation	13 KCY LC	, แเรธเแเธ	adaptive	minimum ty.

- Antigen-presenting cells display antigens on MHC-II molecules to alert helper T cells.
- ✓ Only lymphocytes with matching receptors become activated ensuring precision and preventing overreaction.
 - Like a "lock-and-key" or "Cinderella's slipper" only the correct fit initiates a response.

Space for Personal Notes			



Section C: Humoral Immunity

Overview: Humoral Glossary



<u>Term</u> <u>Definition</u>	
Native B Cell	A 'B cell' that has never encountered its matching antigen before.
Clonal Selection	The process of selecting a lymphocyte with a receptor complementary to the antigen.
Clonal Expansion	The rapid multiplication of selected lymphocytes.
Plasma Cell	An effector B cell that secretes large amounts of antibody.
Memory B Cell	A long-lived B cell that remembers the antigen for faster future response.
Cytokines	Chemical messengers secreted by helper T cells that activate other immune cells.



Sub-Section: Activating Humoral Immunity



How can we deal with extracellular pathogens?



Overview



- Involves the destruction and neutralisation of extracellular antigens via the development and secretion of antibodies.
 - Facilitated by B lymphocytes and T helper lymphocytes each cell has a receptor specific to the antigen.
 - We can describe it in a step-by-step process.

Exploration: The Process of Humoral Immunity

- An antigen that is complementary in shape to the specific receptor present in a B cell will bind to it, and this is called _______
 - Antigens can be encountered in a number of ways. Can you think of some?
- Meanwhile, we have a T helper cell that has become activated by antigen presentation which will recognise this B cell and will secrete cytokines that will cause it to undergo

- Cytokines also stimulate these B cells to differentiate they can either differentiate into ______ or ______.
- They will serve to be our effector cells for the humoral immune response, with B plasma cells being the antibody production factories against that specific antigen.
- B memory cells remain in tissue afterwards for a long period of time, to provide

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Misconception

"B cells can work completely on their own-once they bind an antigen, they automatically start producing antibodies."

TRUTH: B cells need help from activated helper T cells to become fully functional.

- While a B cell can bind directly to a free-floating antigen (this is called clonal selection), it can't undergo clonal expansion or differentiate into plasma/memory cells without receiving cytokine signals from a helper T cell.
- These helper T cells are only activated if they recognise the same antigen on an **antigen-presenting** cell (APC) via MHC-II.
- This "double-check" system ensures **specificity and safety**—the body only launches a full immune response when both B and T cells confirm the same threat.

Analogy: Two Keys to Launch the Attack



- Activating a B cell is kind of like launching a nuclear missile (minus the destruction). You don't want it to happen by accident.
- Just like you need two people turning two separate keys at the same time to confirm a nuclear launch, the immune system uses two separate confirmations before producing antibodies:
 - 1. The **B cell** has to bind the antigen directly (clonal selection).
 - 2. The **helper T cell** must also recognise the same antigen on an antigen-presenting cell (APC) and send cytokines.
- Only when both keys are turned does the B cell get activated, multiply (clonal expansion), and produce plasma/memory cells.
- This double-check system ensures accuracy, prevents unnecessary immune responses, and guarantees the threat is real.





Discussion: Immunological Memory



Can this pathway work in any other way?

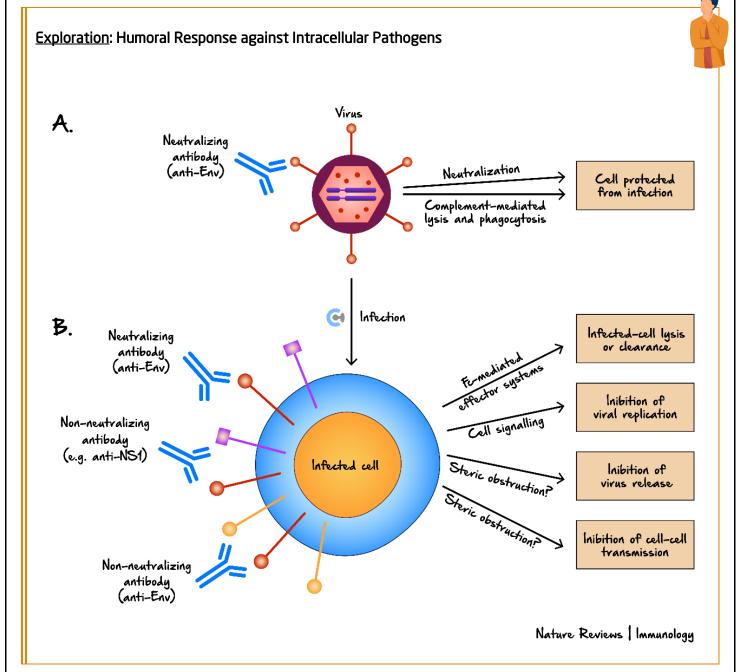
Exploration: Receptor-Mediated Endocytosis





Can this be useful against intracellular pathogens too?





Is there a chance that we DON'T have the correct receptor?





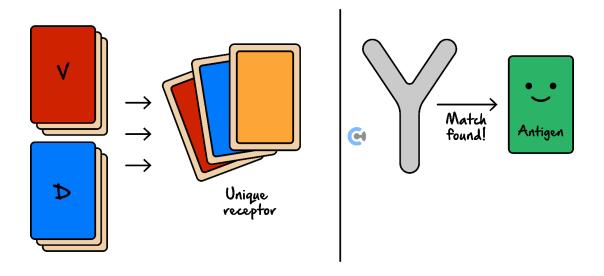
Exploration: V (D) J recombination



<u>Analogy</u>: Shuffling Cards to Make Unique Hands (V(D)] Recombination)



- Imagine you have three decks of cards:
 - One deck has V cards.
 - One has **D** cards.
 - One has J cards.
- To make a unique hand, you draw:
 - One card from each deck.
 - Then, combine them into a set.
- Even though the total number of cards is limited, the number of **possible combinations** is huge. That's exactly what your B cells do.
- During development in the bone marrow, your B cells randomly shuffle and select one V, one D, and one J gene segment. These three segments are joined together to create a unique receptor, like a custom hand of cards.
- This means your immune system has **millions of different B cells**, each with a receptor ready to match a specific "antigen card", even ones the body has never seen before.





NOTE: This idea is beyond the scope of VCE, and has been included to pre-emptively answer some of your understanding based questions!



How can we put this into a question-answering template?

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Sub-Section: Sample Response to Humoral Immunity



NOTE: There is a LOT of variation in the responses and the way schools teach it. VCAA doesn't really assess these minute details so, for the exam anything should work really!



Sample response: Humoral Immunity (The Contour Way)



- Antigen-presenting cells will engulf the pathogen and display antigens on MHC-II markers, travelling to the lymph nodes.
- At the lymph nodes, Naïve B cells can interact directly with an unbound, or raw, antigen via their receptors (CLONAL SELECTION). This can also occur through antigen presentation.
- A Th cell with complementary surface receptors to the antigen is also selected, releasing stimulatory cytokines to activate the selected B cell and induce proliferation (CLONAL EXPANSION).
- As they proliferate, cytokines will also trigger B cells to differentiate into plasma and memory B cells.
- Plasma cells produce and secrete specific antibodies to the antigen, whereas memory B cells are long-lived and remain in the tissue providing immunological memory (a faster and greater response to secondary exposure).



Sample Response: VCAA (2021)



- A suitable answer was that the vaccine is taken up by, for example, macrophages and antigens presented on the surface of the cell. The antigen-presenting cell moves into the lymphatic system and is taken to the lymph node. Helper T cell stimulates naïve B cells. Each B cell divides to produce plasma cells, which produce specific antibodies. B memory and/or T memory cells are produced for long-term immunity.
- A suitable description of the sequence of events that occurs in the secondary lymphoid tissue includes any four of the following:
 - An antigen-presenting cell presents the antigen.
 - T helper cells are activated.
 - The T helper cell activates a B cell.
 - The B cell undergoes clonal expansion. Plasma cells are produced.
 - The plasma cells produce antibodies.
- > Students were not required to name the specific secondary lymphoid tissue as part of their response. Standard abbreviations for cell types were accepted (e.g. Th cell for T helper cell).
- Students were able to provide an explanation of clonal expansion without writing the specific term.
- > Students who demonstrated a detailed understanding of the sequence of events wrote accurate answers of varying lengths.

Annotations



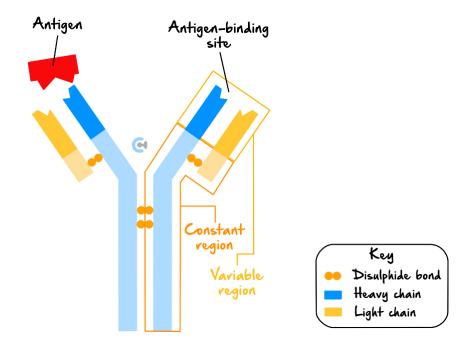
Sub-Section: Antibodies



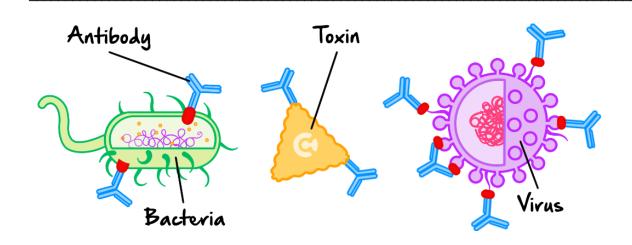
Antibodies



These are proteins that are secreted by B plasma cells to destroy or neutralise pathogens.



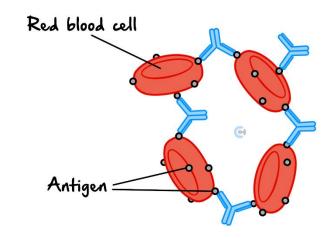
- There are a number of different types of antibodies, including IgG, IgE, IgA, IgD, and IgM.
- They attack and destroy pathogens with a number of mechanisms:
 - Neutralisation -



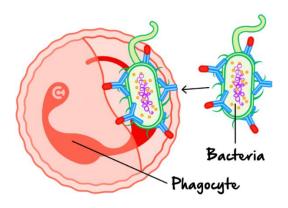


G	Agglutination -			

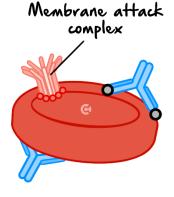
⊙ Immobilisation - _____



G Opsonisation - _____



G Complement activation -





Extension:



<u>Class</u>	<u>Half-life</u> <u>in serum</u>	<u>Presence</u>	<u>Functions</u>	<u>Structure</u>
lgG	21 days	Blood, lymph and extracellular fluid; most circulating antibodies (> 80%); crosses placenta.	Agglutination, complement activation.	
IgM	10 days	Blood and lymph; produced early in infection response.	Agglutination, complement activation.	Disulfide bond Uoining chain
lgA	6 days	Found in secretions such as tears, saliva, and milk.	Mucosal immunity.	Joining Secretory chain protein
lgD	3 days	Blood and lymph; mostly present on B lymphocyte surfaces; small amount in circulation; binds to basophils and mast cells.	Functions not well- understood; possible role in regulating innate immune responses.	
lgE	2 days	Blood and lymph; attaches to mast cells.	Involved in allergic reactions.	



Sub-Section: Case Study



Exploration: Ali, the Knight has been Injured!



- Ali the Knight is injured...
- Ali is stabbed by a rusty sword, trying to courageously defend Baghdad against the Mongols. The pathogen enters through broken skin.
- Stage 1: First Line of Defence
 - Q: What line of defence has been breached?
 - Q: Which part of the innate immune system responds next?
- Stage 2: Antigen Presentation
 - A dendritic cell engulfs the pathogen and presents it on MHC II.
 - Q: What is the name of this type of cell?
 - Q: Where does this cell travel to present the antigen?



- Stage 3: Clonal Selection & Activation
 - In the lymph node, a helper T cell is activated, which then helps activate a B cell with a matching receptor.
 - Q: What process is occurring here (starts with C)?
 - Q: What does the helper T cell secrete to activate the B cell?
- Stage 4: Clonal Expansion & Differentiation
 - The B cell divides and forms two types of cells.
 - Q: What are the names of these two types?
 - Q: What does each type do?
- Stage 5: Destruction of the Pathogen
 - e Plasma cells secrete antibodies that neutralise the pathogen and mark it for destruction.
 - Q: Name one antibody mechanism that helps destroy the pathogen.
- Stage 6: Immunological Memory
 - Months later, Ali is stabbed again–but this time, the immune response is faster.
 - Q: Which cell type is responsible for this faster secondary response?
 - Q: How is the second exposure different from the first?
- What will happen when Ali the Knight gets stabbed with a rusty sword again?



Key Takeaways



✓ Humoral Immunity

- Humoral immunity protects against extracellular pathogens by producing antibodies.
- The process begins with clonal selection:
 - A 'B cell' binds to a free-floating antigen with a complementary receptor.
- The same antigen must be recognised by a helper T cell presented on an APC.
 - The helper T cell becomes activated and secretes cytokines.
- G Cytokines trigger clonal expansion:
 - The activated B cell divides to produce many identical B cells.
- These B cells differentiate into:
 - Plasma cells: Antibody-producing factories that release large amounts of specific antibodies.
 - Memory B cells: Long-lived cells that provide rapid response on re-infection.
- This dual-signal system (antigen binding + helper T cell cytokines) acts as a "double-check" for immune accuracy.
- B cells can also perform receptor-mediated endocytosis and act as APCs.
 - This ability allows them to present antigen to helper T cells and receive cytokine support.
- Humoral immunity is most effective before pathogens enter cells.
 - Useful against viruses in the bloodstream or bacteria in body fluids.
- Antibody diversity is generated via V(D)| recombination in developing B cells.
 - This gene shuffling process creates millions of unique B cell receptors enabling recognition of countless antigens.



Antibodies

- Antibodies are Y-shaped proteins secreted by plasma cells that bind specifically to antigens.
 - Each antibody matches a specific antigen like a lock and key.
- Five major classes of antibodies (immunoglobulins), each with distinct roles:
 - IgG: Most abundant; found in blood, lymph, and extracellular fluid; crosses placenta; supports agglutination and complement activation.
 - IgM: First antibody released during an infection; large and effective at agglutination and activating complement.
 - IgA: Found in secretions (tears, saliva, breast milk); important in mucosal immunity.
 - IgE: Binds to mast cells and triggers allergic reactions; helps defend against parasitic infections.
 - IgD: Present in small amounts on immature B cells; role in immune regulation not fully understood.
- Mechanisms by which antibodies eliminate or weaken pathogens:
 - Neutralisation: Block pathogen binding to host cells by coating active sites.
 - Agglutination: Clump multiple pathogens together, making them easier for phagocytes to engulf.
 - Immobilisation: Bind to flagella or cilia, reducing motility.
 - Opsonisation: Tag pathogens to enhance uptake by phagocytes.
 - Complement activation: Initiate a cascade that forms membrane attack complexes, lyses cells, and recruits immune components.

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Contour Check

□ <u>Learning Objective</u>: [3.3.1] - Identify the structure of the lymphatic system, including primary & secondary lymphatic tissue

Key Takeaways
☐ The lymphatic system transports a clear fluid known as
 This fluid originates from leaked plasma in the [interstitial / intracellular] space.
☐ Lymphatic capillaries collect this fluid and transport it through vessels back to the [heart / lungs].
These vessels contain [one-way / two-way] valves.
 Movement of lymph relies on [skeletal muscle / cardiac muscle] contractions.
The lymphatic system includes primary and secondary lymphoid tissues.
O Primary lymphoid tissues include the and
These are sites of lymphocyte development and maturation.
 Secondary lymphoid tissues include and
These are sites where lymphocytes encounter antigens and initiate immune responses.
Lymph nodes filter lymph and contain clusters of immune cells like and
 These nodes are classified as [primary / secondary] lymphoid tissue.



Learning Objective: [3.3.2] - Identify the role of the lymphatic system in fighting infections			
Key Takeaways			
☐ The lymphatic system serves as a transport network for			
It moves antigen-presenting cells (APCs) to lymphoid tissues for immune activation.			
☐ It supports immune function by:			
Filtering for pathogens.			
Housing lymphocytes that can detect and respond to			
☐ It maintains fluid balance by returning leaked fluid to the circulatory system.			
Without this return, tissues would experience			
☐ The system prevents systemic spread of pathogens by trapping them in befor they return to the bloodstream.	e		



 <u>Learning Objective</u>: [3.3.3] - Explain antigen presentation as a means to initiate the adaptive immune response
Key Takeaways
Antigen presentation occurs when an APC engulfs a pathogen and presents its antigen on an molecule.
The molecule involved is [MHC-I / MHC-II].
This antigen is recognised by a with a complementary receptor.
• The cell that recognises this antigen is a [helper T / cytotoxic T] lymphocyte.
This interaction activates the helper T cell to release, triggering the adaptive response.
Only lymphocytes with a receptor that fits the presented antigen are

O This process ensures [specificity / generality] in immune activation.



 <u>Learning Objective</u>: [3.3.4] - Identify the characteristics of the adaptive response which differentiate it from the innate response

Key Takeaways
The adaptive immune system is the [third / second] line of defence.
Two key features that differentiate it are:
Each cell targets one unique antigen.
O: Allows quicker and stronger response on re-exposure.
The adaptive system involves lymphocytes that undergo when activated.
Helper T cells coordinate immune responses by activating and cells.
Unlike the innate system, the adaptive response takes [longer / shorter] to initiate but is more precise and lasting.



Learning Objective: [3.3.5] - Identify & explain the humoral response as a response to extracellular pathogens, including the role of B and T Helper lymphocytes
Key Takeaways
☐ The humoral immune response targets [extracellular / intracellular] pathogens.
☐ B cells are activated through a two-step process:
First, an antigen binds directly to a B cell receptor ().
 Second, a helper T cell that has recognised the same antigen on an APC secretes
☐ These cytokines trigger B cell and differentiation.
□ Differentiated B cells become:
cells that produce antibodies.
cells that persist in the tissue for future response.
□ B cells can also act as APCs through endocytosis.
☐ This response is most effective before pathogens enter [cells / tissues].
□ The helper T cell involved in this process is a [Th / Tc] cell.



 Learning Objective: [3.3.6] - Explain the significance of memory cells to generate immunological memory, & how that prevents future infections 				
Key Takeaways				
☐ Memory cells are formed during the [primary / secondary] immune response.				
☐ They are long-lived and remain in [blood / tissue], providing faster activation upon re-exposure.				
On second exposure, memory cells produce a [faster / slower] and [stronger / weaker] immune response.				
☐ This quicker response prevents the pathogen from causing significant				
Immunological memory is the biological basis for effective				
Learning Objective: [3.3.7] - Differentiate between extracellular & intracellular threats				
Key Takeaways				
Key Takeaways Extracellular threats exist [outside / inside] host cells.				
Extracellular threats exist [outside / inside] host cells.				
 Extracellular threats exist [outside / inside] host cells. Examples: Most and free-floating 				
 Extracellular threats exist [outside / inside] host cells. Examples: Most and free-floating Targeted by the immune response. 				
 Extracellular threats exist [outside / inside] host cells. Examples: Most and free-floating Targeted by the immune response. Intracellular threats reside [outside / inside] host cells. 				
 Extracellular threats exist [outside / inside] host cells. Examples: Most and free-floating Targeted by the immune response. Intracellular threats reside [outside / inside] host cells. Examples: replicating within host cells. Targeted by the immune response. Different immune cells are specialised to deal with each type: 				
 Extracellular threats exist [outside / inside] host cells. Examples: Most and free-floating Targeted by the immune response. Intracellular threats reside [outside / inside] host cells. Examples: replicating within host cells. Targeted by the immune response. 				



□ <u>Learning Objective</u>: [3.3.8] – Explain how antibodies are used to fight against infections, and draw their structure

Key Takeaways
Antibodies are secreted by cells and bind specifically to antigens.
Their structure is shaped like a, with variable regions that determine antigen binding.
Types of antibodies:
o IgG: Crosses placenta; high in circulation; performs and activation.
IgM: First produced; effective at and activating complement.
o IgA: Found in secretions (e.g., tears, saliva); protects surfaces.
o lgE: Binds to mast cells; involved in reactions and parasite defence.
o lgD: Found on immature cells; function unclear.
Antibody functions:
Neutralisation: Block pathogen entry into cells by coating
• Agglutination: Clump pathogens for easier by phagocytes.
Opsonisation: Tag pathogens to enhance uptake by
Immobilisation: Bind to flagella or cilia to reduce
• Complement activation: Initiate cascade leading to cell and inflammation.

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