# AQA Biology A-level

## 2.4 - Cell recognition and the immune system

Flashcards

# What is an antigen?

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- Cell-surface molecule which stimulate immune response.
- Usually (glyco)protein, sometimes (glyco)lipid or polysaccharide.
- Immune system recognises as “self” or “non-self” = enables identification of cells from other organisms of same species, pathogens, toxins & abnormal body cells.

# How does phagocytosis destroy pathogens?

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1. Phagocyte moves towards pathogen via **chemotaxis**.
2. Phagocyte engulfs pathogen via endocytosis to form a **phagosome**.
3. Phagosome fuses with lysosome (**phagolysosome**).
4. Lysozymes **digest pathogen**.
5. Phagocyte absorbs the products from pathogen hydrolysis.

# Explain the role of antigen-presenting cells (APCs).

# Explain the role of antigen-presenting cells (APCs).

Macrophage displays antigen from pathogen on its surface (after hydrolysis in phagocytosis).

Enhances recognition by $T_H$ cells, which cannot directly interface with pathogens/ antigens in body fluid.

Give 2 differences between specific and nonspecific immune responses.

# Give 2 differences between specific and nonspecific immune responses.

**nonspecific** (inflammation, phagocytosis) = same for all pathogens

**specific** (B & T lymphocytes) = complementary pathogen

**nonspecific** = immediate

**specific** = time lag

Name the 2 types of specific immune response.

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- cell-mediated
- humoral

# Outline the process of the cell-mediated response.

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1. **Complementary** $T_H$ lymphocytes bind to foreign antigen on APC.
2. Release cytokines that stimulate:

a) clonal expansion of complementary $T_H$ cells (rapid mitosis): become **memory cells** or trigger **humoral response.**

b) clonal expansion of **cytotoxic T cells** ($T_C$): secrete enzyme **perforin** to destroy infected cells.

# Outline the process of the humoral response.

# Outline the process of the humoral response.

1. **Complementary** $T_H$ lymphocytes bind to foreign antigen on antigen-presenting T cells.
2. Release cytokines that stimulate clonal expansion (rapid mitosis) of **complementary B lymphocytes**.
3. B cells differentiate into **plasma cells**.
4. Plasma cells secrete **antibodies** with complementary variable region to antigen.

# What is an antibody?

# What is an antibody?

proteins secreted by plasma cells

**Quaternary structure**: 2 '**light chains**' held together by disulfide bridges, 2 longer '**heavy chains**'.

**Binding sites** on **variable region** of light chains have specific tertiary structure **complementary to an antigen**.

The rest of the molecule is known as the **constant region**.

# How do antibodies lead to the destruction of a pathogen?

How do antibodies lead to the destruction of a pathogen?

Formation of **antigen-antibody complex** results in **agglutination**, which **enhances phagocytosis**.

# What are monoclonal antibodies?

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Antibodies produced from a single clone of B cells.

# What are memory cells?

# What are memory cells?

- Specialised $T_H$/ B cells produced from primary immune response.
- Remain in low levels in the blood.
- Can divide very rapidly by mitosis if organism encounters the same pathogen again.

# Contrast the primary and secondary immune response.

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**secondary response**:

- Faster rate of antibody production.
- Shorter time lag between exposure & antibody production.
- Higher concentration of antibodies.
- Antibody level remains higher after the secondary response.
- Pathogen usually destroyed before any symptoms.

# What causes antigen variability?

# What causes antigen variability?

1. Random genetic mutation changes DNA base sequence.
2. Results in different sequence of codons on mRNA
3. Different primary structure of antigen = H-bonds, ionic bonds & disulfide bridges form in different places in tertiary structure.
4. Different shape of antigen.

# Explain how antigen variability affects the incidence of disease.

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- Memory cells no longer complementary to antigen = individual not immune = can catch the disease more than once.
- Many varieties of a pathogen = difficult to develop vaccine containing all antigen types.

Compare passive and active immunity. Give examples of both types.

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- both involve antibodies
- can both be natural or artificial

**passive natural**: antibodies in breast milk/ across placenta

**passive artificial**: anti-venom, needle stick injections

**active natural**: humoral response to infection

**active artificial**: vaccination

# Contrast passive and active immunity.

# Contrast passive and active immunity.

| Passive | Active |
| --- | --- |
| no memory cells & antibodies not replaced when broken down = short-term | memory cells produced = long-term |
| immediate | time lag |
| antibodies from external source | lymphocytes produce antibodies |
| direct contact with antigen not necessary | direct contact with antigen necessary |

# Explain the principles of vaccination.

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1. Vaccine contains dead/ inactive form of a pathogen or antigen.
2. Triggers primary immune response.
3. Memory cells are produced and remain in the bloodstream, so secondary response is rapid & produces higher concentration of antibodies.
4. Pathogen is destroyed before it causes symptoms.

# What is herd immunity?

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Vaccinating large proportion of population reduces available carriers of the pathogen.

Protects individuals who have not been vaccinated e.g. those with a weak immune system.

Suggest some ethical issues surrounding the use of vaccines.

Suggest some ethical issues surrounding the use of vaccines.

- production may involve use of animals
- potentially dangerous side-effects
- clinical tests may be fatal
- compulsory vs opt-out

# Describe the structure of HIV.

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- Genetic material (**2 x RNA**) & **viral enzymes** (integrase & reverse transcriptase) surrounded by **capsid.**
- Surrounded by viral **envelope** derived from host cell membrane.
- GP120 **attachment proteins** on surface.

# How does HIV result in the symptoms of AIDS?

# How does HIV result in the symptoms of AIDS?

1. Attachment proteins bind to complementary CD4 receptor on $T_H$ cells.
2. HIV particles replicate inside $T_H$ cells, killing or damaging them.
3. AIDS develops when there are too few $T_H$ cells for the immune system to function.
4. Individuals cannot destroy other pathogens & suffer from secondary diseases/ infections.

# Why are antibiotics ineffective against viruses?

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Antibiotics often work by damaging murein cell walls to cause osmotic lysis. Viruses have no cell wall.

Viruses replicate inside host cells = difficult to destroy them without damaging normal body cells.

# Suggest the clinical applications of monoclonal antibodies.

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- Pregnancy tests by detecting HCG hormones in urine.
- Diagnostic procedures e.g. ELISA test
- Targeted treatment by attaching drug to antibody so that it only binds to cells with abnormal antigen e.g. cancer cells due to specificity of tertiary structure of binding site.

# Explain the principle of a direct ELISA test.

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detects presence of a specific antigen

1. Monoclonal antibodies bind to bottom of test plate.
2. Antigen molecules in sample bind to antibody. Rinse excess.
3. Mobile antibody with ‘reporter enzyme’ attached binds to antigens that are ‘fixed’ on the monoclonal antibodies. Rinse excess.
4. Add substrate for reporter enzyme. Positive result: colour change.

# Explain the principle of an indirect ELISA test.

# Explain the principle of an indirect ELISA test.

detects presence of an antibody against a specific antigen

1. Antigens bind to bottom of test plate.
2. Antibodies in sample bind to antigen. Wash away excess.
3. Secondary antibody with ‘reporter enzyme’ attached binds to primary antibodies from the sample.
4. Add substrate for reporter enzyme. Positive result: colour change.

Suggest some ethical issues surrounding the use of monoclonal antibodies.

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- Production involves animals.
- Drug trials against arthritis & leukaemia resulted in multiple organ failure.