Monoclonal Antibodies Notes

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Monoclonal antibodies: are identical copies of a single type of antibody.

They are made by cloning one type of B lymphocyte that produces an antibody specific to a certain antigen.

Before we go on let's talk a little bit about lymphocytes…

Lymphocytes

Lymphocytes: are a type of white blood cell that help defend the body against pathogens (such as bacteria and viruses). Lymphocytes are a different type of white blood cell compared to phagocytes.

There are two main types of lymphocytes:

1. **B lymphocytes** (B cells) – produce antibodies that bind to antigens on pathogens. They also make antitoxins.
2. **T lymphocytes** (T cells) – destroy infected cells or help B cells do their job (we don't need to know much about these for our exam).

Antibodies and Antigens

What is an antibody and what is an antigen?

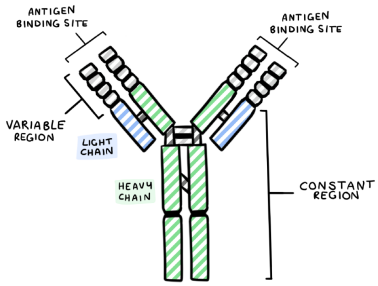
An antibody: a protein made by B lymphocytes that binds to a specific antigen.

An antigen: a molecule (usually a protein) on the surface of a pathogen that triggers an immune response.

For any antigen that enters the body, the B cells can produce antibodies with the exact complementary shape and size to fit them.

The figure shows the structure of an antibody.

You do not have to know the structure. I just thought it might be nice to show you what one looks like 😊



General structure of an antibody

Production of Monoclonal Antibodies

When monoclonal antibodies pop up in exams a common question to be asked is "***how are monoclonal antibodies produced?***". Below is **written the ideal answer,** please learn all of the steps.

Step 1: A mouse is injected with a specific antigen.

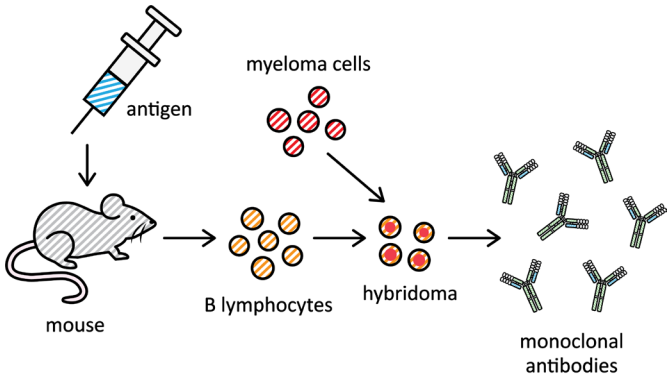
Step 2: The mouse's B lymphocytes produce antibodies against the antigen.

Step 3: These cells are collected from the mouse's spleen during a small operation.

Step 4: They are fused with myeloma cells (cancerous white blood cells) to form hybridoma cells.

Step 5: Hybridoma cells divide rapidly and produce large quantities of identical (monoclonal) antibodies.

Note: If the question asks about a test for example, a pregnancy test, mention that the antibodies are attached to the test strip.



Uses of Monoclonal Antibodies

Monoclonal antibodies are used in pregnancy tests to detect a hormone called **hCG** (human chorionic gonadotropin), found only in the urine of pregnant women. We don't need to know what hCG stands for, just hCG will do fine 😊

How do pregnancy tests work? Below we have the step by step process of how a pregnancy test works.

Step 1: The woman urinates on the test stick. The stick contains monoclonal antibodies that are specific to hCG.

Step 2: If she is pregnant, hCG in the urine will bind to the monoclonal antibodies on the stick.

Step 3: These antibodies are attached to a blue dye or colour marker. When hCG binds, the antibodies move along the stick and get trapped in a test zone.

Step 4: This causes a line or colour change to appear — this is a positive result.

Step 5: A second line (the control line) always appears to show the test worked properly, whether or not the person is pregnant.

How does the control line work? On the test strip there are antibodies that bind to hCG if it's present. That makes sense. So, does that mean that there are other antibodies also on the test stick? Yes 😊 these are called control line antibodies.
They don't get assessed in the GCSE at all but it's handy to know how the full test works to fully understand it.

- Control line antibodies are fixed in place in the control window, but they don't bind to hCG.
- Instead, they bind to the dye-tagged antibodies, whether or not those antibodies are carrying hCG.
- So even if the woman is not pregnant (no hCG), the dye-labelled antibodies still flow past and bind to the control line, causing a colour change. A line in the control window tells us that the test has worked correctly.

Cancer Diagnosis and Treatment

Cancer cells have unusual antigens on their surface. Monoclonal antibodies can be made to bind to these antigens. When injected into a patient, they stick to cancer cells and can be linked to markers (e.g., dyes or radioactive substances) to help locate tumours.

When injected into a person's body, the monoclonal antibodies will bind with these cancer cells and clump them together. This makes it easier to identify a **cancerous tumour**, which can then be treated or removed.

Monoclonal antibodies have also been designed to treat cancer by:

- carrying drugs that have been attached to them, to the tumour.
- encouraging the **immune system** to attack the cancer cells directly.

Other Diagnostic Uses

Monoclonal antibodies can help identify infections, such as: **HIV** ,**AIDS**, herpes and chlamydia.

Some antibodies are attached to fluorescent dyes that glow under UV light, making it easier to detect specific antigens in a sample.

The Advantages of using Monoclonal Antibodies

- Unlike some anti-cancer drugs, they don't kill adjacent cells. Can be produced in huge quantities, quickly.
- Can be used in diagnostic testing including pregnancy test kits, or detecting HIV and chlamydia.
- Can treat conditions like cancer by carrying drugs directly to tumour cells, minimizing damage to healthy tissue.

The Disadvantages of Monoclonal Antibodies

- **Unexpected side effects**: They cause more side effects than originally expected, such as fever, vomiting, and low blood pressure.
- **Ethical issues**: The production process requires the use of live animals.
- **Production difficulties**: Developing them and attaching them to drugs is an expensive and highly complex process.