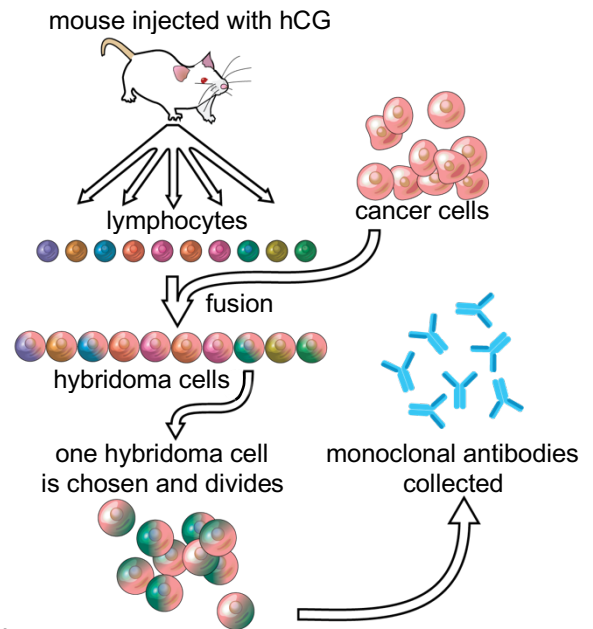


Monoclonal antibodies

During pregnancy, a substance called hCG appears in the urine. Pregnancy test strips detect hCG using **antibodies** that only stick to hCG. To make test strips, vast numbers of the antibodies are needed.

To make the antibodies, hCG is injected into a mouse. Some of its lymphocytes then produce antibodies that stick only to hCG. The mouse lymphocytes are collected.

However, these lymphocytes do not undergo **cell division** and so obtaining enough of them would take a very long time. To overcome this, the lymphocytes are fused with cancer cells to form **hybridoma cells**. These make antibodies *and* divide to make copies (**clones**) of themselves, which gives us a limitless supply. The antibodies are **monoclonal** because they come from clones of one hybridoma cell.



Test strips

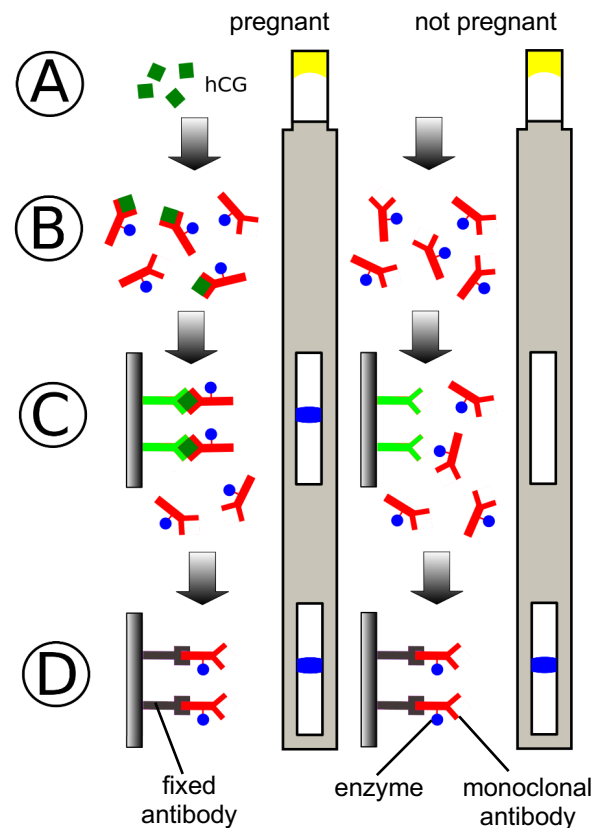
Enzymes are attached to monoclonal antibodies for use in test strips. In a pregnancy test strip, urine is added to zone A (in the diagram) and soaks along the strip. In zone B, any hCG molecules stick to the monoclonal antibodies (but there are more antibodies than hCG molecules).

The urine carries the monoclonal antibodies into zone C. Here, there are antibodies (in green) that also stick to hCG. But these are fixed in place and cannot move. They trap the monoclonal antibodies that are attached to hCG. The monoclonal antibodies without hCG carry on moving.

Zone D is to show that the test strip is working. It contains fixed antibodies that capture the monoclonal antibodies.

Zones C and D contain a colourless substrate for the enzyme. The enzymes on the monoclonal antibodies that are stuck in either of these zones, slowly change the substrate into a coloured substance.

Similar test strips are being developed to find out if someone has antibodies against SARS-CoV-2. If a person has antibodies against the virus it means that they have had COVID-19.



Find out

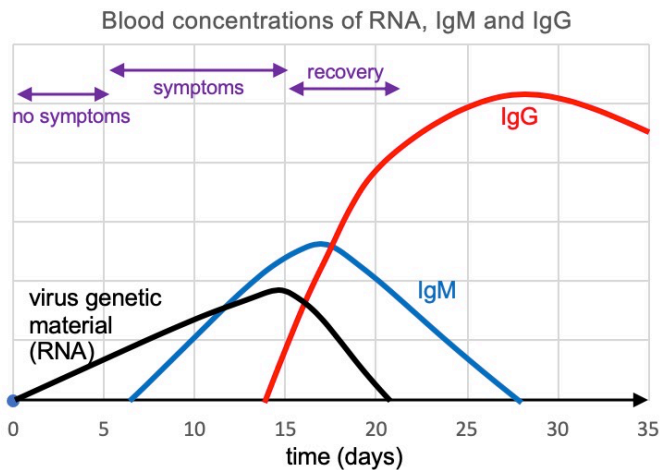
- I. 1. Apart from test kits, describe two further uses of monoclonal antibodies.

2. From what mouse organ are the lymphocytes collected. _____

3. Who won a Nobel Prize for their work on monoclonal antibodies?

Test yourself

4. The graph shows changes in the concentrations of three substances in blood during COVID-19 infection. IgG and IgM are two different types of antibody, which are different shapes and sizes.



- a. Name the molecule used as the virus' genetic material. _____

- b. Explain the shape of the graph for this material. _____

- c. The virus genetic material is detected in a PCR test. IgG and IgM could be detected in a test strip. Complete the table to show the results of these tests at different stages of infection. Use + for positive and – for negative.

Test results (+ / -)			Stage of infection
PCR	IgM	IgG	
			No symptoms and no sign of previous infection.
			No symptoms but is infected.
			No symptoms but has previously been infected.
			Symptoms present for less than a week.
			Symptoms present for a week or more.

- d. Describe how to get lymphocytes to make anti-IgG and anti-IgM antibodies for the test.

Check-up

- I. Check your answers.
- II. Design an antibody test strip for COVID-19. Present your idea in a similar way to the diagram on page 1, showing what type of antibodies will be present in each zone.

Answers

Note to home educators

This worksheet is designed to support understanding of monoclonal antibodies. You may wish to share these objectives with students:

- Define the term monoclonal antibody. (GCSE Biology Higher Tier)
- Define the term hybridoma cell. (GCSE Biology Higher Tier)
- Describe how monoclonal antibodies are produced using lymphocytes. (GCSE Biology Higher Tier)
- Explain how monoclonal antibodies are used in pregnancy testing. (GCSE Biology Higher Tier)

To fully access this sheet, students will need a knowledge of enzymes, lymphocytes and antibodies. It may be helpful for students to use Worksheets 8, 9 and 16 before this one. Other sheets in the series are available: <https://shwca.se/covid19science>

It is suggested that students complete the worksheet independently, using the internet for questions 1 - 3. Question 4 should be completed without help from additional sources.

This material is from the GCSE 9-1 Biology specification, Higher Tier (Years 10 and 11).

If you wish to check the answers, keep this part of the sheet away from the questions!

1. Two from: delivering (cancer) drugs to specific parts of the body, detection of tumours in scanners, identifying different diseases (e.g. different types of leukaemia), isolating specific types of cell, helping to prevent transplant rejection, possibly treating viral diseases (by injecting monoclonal antibodies against a virus in the early stages of infection).
2. spleen
3. Niels K. Jerne, Georges J.F. Köhler and César Milstein (1984)
4. a. RNA
b. Increases as the virus replicates/makes copies of itself, decreases once there are enough of the correct antibodies/lymphocytes/white blood cells to destroy the virus.

c. table on right

d. Take IgM and IgG antibodies from someone with COVID-19. Inject these into mice. Collect the lymphocytes.

Test results (+ / -)			Stage of infection
PCR	IgM	IgG	
-	-	-	No symptoms and no sign of previous infection.
+	-	-	No symptoms but is infected.
-	-	+	No symptoms but has previously been infected.
+	+	-	Symptoms present for less than a week.
+	+	+	Symptoms present for a week or more.

- II. This is challenging!

Monoclonal anti-IgG and anti-IgM antibodies would both be in zone B. Zone C would have two subzones. One C subzone contains fixed antibodies that attach to IgG (from blood with a COVID-19 infection). This traps the monoclonal anti-IgG antibodies that have bound to IgG antibodies from the blood. The other C subzone contains fixed antibodies that attach to IgM. This traps the monoclonal anti-IgM antibodies that have bound to IgM antibodies from the blood. Zone D contains two types of fixed antibody – those that attach to monoclonal anti-IgG and those that attach to monoclonal anti-IgM.