Hello. I’m Dr Alex Lathbridge and this is Bitesize Biology.

This is the fifth episode in a six-part series on Infection and Response. In this episode we’re going to talk about Monoclonal Antibodies.

A quick heads up: today we are going to be talking about testing on animals.

This technology helped win the Nobel Prize in 2018 because scientists found a way to use it to treat cancer.

It’s the reason why scientists in the lab don’t have to cover fish in urine (this is relevant later) and I am willing to bet good money that you’ve seen monoclonal antibodies in the shops without even realizing it.

By now, we’re good on the basics of antibodies? (If not, no worries, go back to episode 2 of this series if you’re really stuck) but here’s a quick recap:

Antibodies are very specific. They work by binding onto the specific antigens found on the surface of pathogens. So only one type of antibody will bind to one type of antigen.

But here’s where it gets cool.

Remember how we’ve been describing antigens so far? They’re like ID cards for every cell, not just pathogens.

Well, scientists worked out that it was possible to make antibodies that could identify and bind to antigens on almost anything, not just pathogens.

This is where Monoclonal Antibodies come in and chances are you’ve seen them in use without realising it, so grab a pen and write this down:

First up: Monoclonal. Mono means one. Clonal means clone.

In easy terms, monoclonal antibodies are created by exposing the immune system to a specific antigen and when the antibodies get generated, scientists use cloning techniques in the lab to make lots and lots of them, basically letting us store lots of one specific antibody. Hence the term, monoclonal antibodies.

Let’s say we’re in the lab and we want to make a batch of monoclonal antibodies to target an antigen found in something like peanuts, for people with peanut allergies. Peanuts have lots of different antigens so we’ll just pick one for now.

So this is going to involve live mice, spleen cells, and a cancer cell. Obviously don't do this at home.

Let's get into the five steps you need to know to make a monoclonal antibodies:

1. First thing, you get your mouse and vaccinate it by injection with a specific antigen (in our

case, this is an antigen found in peanuts)

2. The mouse naturally responds to the peanut antigen, makes lymphocytes which produce antibodies that specifically target our injected peanut antigen. So we've got ourselves some antibody producing lymphocytes, but it's slow.

3. We do a little operation on the mouse to remove spleen cells which contain these lymphocytes.

4. These spleen cells are then combined with human cancerous cells, which are called myeloma cells, this combination are called hybridoma cells. Literally hybrid myeloma. Hybridoma cells.

5. These hybridoma cells divide indefinitely and reproduce rapidly, making clones of themselves and creating millions of monoclonal antibodies specific to the original antigen. These hybridoma cells make the peanut antibody that we want and that's what we need.

I know your first question: why on earth have we just combined spleen cells and cancerous cells? That doesn't sound good.

Fair question and that is what is really clever about this.

So remember what are cancers caused by? Cells that divide rapidly and uncontrollably.

So what we've done is say "let's turn that negative into a positive."

So instead of waiting for lymphocytes to divide in the spleen, let's combine those spleen cells with cancerous cells that we know divide really quickly, and that combination – the hybridoma – will churn these monoclonal antibodies out like a factory.

So that means that we can pick and choose which specific antibodies to make and make a whole lot of them.

That monoclonal antibody that we just made to target an antigen found in peanuts could theoretically be used to help people who get terrible allergic responses to them.

So let's take monoclonal antibodies out of the lab and into the real world.

Now remember, I said you've probably seen monoclonal antibodies in shops without realising it?

That is because they are the basis of pregnancy tests. Yes, the stick that people urinate onto that changes colour depending if they're pregnant or not.

Why? Well, a hormone called HCG is present in the urine of pregnant women. Monoclonal antibodies are used in pregnancy tests by binding specifically to HCG, causing the colour change, so someone can find out whether they are pregnant or not.

It’s a good thing we have monoclonal antibodies now because before home testing kits were invented in the 1970s, scientists used animals, such as certain toads and fish to test for pregnancy. Women’s urine would be put in the water of a specific type of see-through fish. If HCG was present in the urine, one of its organs would expand and this would confirm pregnancy. And you could see it because it was a see-through fish.

How can monoclonal antibodies be used to diagnose and treat cancer?

Antigens our cells’ ID cards, so it makes sense that cancerous cells have their own specific antigens.

Monoclonal antibodies can be designed to specifically bind to these antigens on the cancerous cells, and clump them together.

This is good because they have the potential to:

1. identify a cancerous tumour, so it can help with possible treatment or removing the tumour.

2. they can help carry drugs to target the specific cancerous cells.

3. they can encourage your immune systems to attack the cancer cells.

We’ve been very positive about monoclonal antibodies and like I said, this technology helped win a Nobel Prize.

But there are some pros and cons. Let’s start with the pros:

Monoclonal antibodies can be produced very quickly even though it can be initially time-consuming when they are made for the first time

They only bind to specific antigens or target cells and they do not affect any other healthy cells, and that’s good.

But there are cons:

Monoclonal antibodies are very expensive to produce.

There are ethical concerns about using animals in the lab.

Scientists originally thought that monoclonal antibodies would be a “magic bullet” and identify and treat many medical conditions. But tests have shown that unfortunately this is not the case. The human body is super complicated and some interactions with monoclonal antibodies get unwanted side effects, and so they cannot be as widely used as doctors first thought.

I’m Dr Alex Lathbridge and this is Bitesize Biology. You can listen to all episodes now on BBC Sounds.