

**S100: Science: a foundation course**  
**S100/17: Genetic code**

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**Clip transcript: A demonstration of the experimental methodology used to perform the transformation experiment**

**Brian Cox:**

This experiment is done with bacteria and it is the first and classic experiment demonstrating that DNA is a carrier of genetic information. Here are two cultures of bacteria. They are identical, except in one respect. This culture, the cells in this culture are lacking an enzyme which is required to make a simple amino acid Tryptophan. The cells in this culture possess that enzyme and so they can make Tryptophan. Now I'm going to show you how we can tell the difference, quite simply, between these two cultures. Here are two plates. They contain a simple growth medium. This plate has had the amino acid, Tryptophan added to it. This plate, the medium in this plate has no Tryptophan in it. Now I'm going to put cells from both cultures on both plates. Let's mark the plates to start with so we know what we're doing. First the cells from the culture, the cells that can make their own Tryptophan. Now I'm flaming off this wire loop to sterilise it. In all bacteriological experiments we have to be careful that we don't grow anything on our plates, we don't get anything on our plates except the cells which we're interested in and burning them off the surfaces of things which will come in contact with the medium is the way we do it. So we take some cells from this culture and streak them first on this plate and then on that one. And then we do the same with the cells from the other culture, the cells which cannot make their own Tryptophan.

Now how do we know, how do we tell whether the cells are able to make their Tryptophan or not? Well if they can make Tryptophan they will be able to grow on the medium which contains none and to show this, to find this out we will have to incubate the plates for a time. Well we haven't got time to wait so I have some dishes to show you which were streaked out a couple of days ago. They've been in this incubator and the cells have been growing. First of all, here is the dish which contained a medium which had Tryptophan added to it. I'll put it up so that you can see what's happened. You will notice that there is a substantial bacterial growth on both sides of the plate. Both cultures, cells of both cultures have been able to grow on this medium. Now here is the other plate, the one which contains a medium that has no Tryptophan in it and you will see that there is a growth on only one side of the plate, the side where we put cells from the culture which could make its own Tryptophan. The cells from the other culture on the other side of the plate have been unable to grow, they need that Tryptophan, they can't make it so they can't grow.

Well now, what we're going to try and do is transform these cells, the ones which cannot make their own Tryptophan into cells which can make Tryptophan. To do this we have to transfer the ability to make Tryptophan from cells which can make it. And as we think that the DNA is the material which will give the cells this information we have to extract the DNA from these cells, the ones which are able to make their own Tryptophan. Now this is quite a lengthy process and we haven't got time to show you the whole of it. We start off by breaking open the cells with an enzyme called Lysozyme. And then we go through a chemical procedure which is relatively simple and we end up with a cell extract which contains a solution of DNA and various other cell products and what we have to, what we want to do is a final stage is prepare, is purify, remove the DNA from the solution and so that we end up with a purified DNA solution from these cells. And to do this we precipitate the DNA out of solution using alcohol. We carefully layer alcohol on top of our cell extract and we get two layers of

liquid, the cell extract at the bottom and the alcohol layer on top and where the two layers meet, a cloudy precipitate forms and the DNA molecule is a fibre so the precipitate is a fibrous precipitate and we can collect it by spooling it onto a glass rod. There it is spooled on the glass rod and now we dissolve off the spooled fibres from the glass rod in a sterile dilute salt solution. Now then, in that solution we have purified DNA molecules from cells which were able to make their own Tryptophan.

What have we to do? Well the experiment is to see whether these cells which cannot make their own Tryptophan, will take up DNA and use it to provide information which will enable them to make Tryptophan. So we add some of this sterile DNA, purified DNA solution. One ml will do, to these cells keeping them sterile and we let the mix stand for a time. Now what we have to find out is whether the, whether any of the cells in that mix acquire the ability to make Tryptophan. And how do we do that? Well you know the answer. We have a medium which can tell us whether they're going to make Tryptophan. Here is a dish of that medium and what we have to do obviously, is place some of these cells on the medium and see if any of them can grow. We take a tenth of a millilitre, pipette it on the surface of the plate and then we can spread the cells evenly all over the surface of the plate with a sterile glass rod. Cool it down first. There we are. Now again it'll be two days before we can see whether any cells are able to make their own Tryptophan because they have to incubate. And again we have some plates to show you which were plated out two days ago. But before I show you them, there were two controls which are needed to establish this experiment and you ought to be thinking about what those controls are while I'm getting the plates out of the incubator. Well first of all, here is the plate from two days ago on which we plated out the mix, the mix of cells which are unable to make their own Tryptophan plus DNA extracted from the other kind of cells. Now, you can see, all over the surface of this plate, a number of colonies have grown. Each of those colonies contains about a thousand million cells but each has grown from a single cell, a cell which has acquired the ability to make Tryptophan. And these cells were from the mix of DNA plus cells that were unable to make Tryptophan.

Now what about those controls? Well clearly we need to establish that neither the DNA nor those cells in the mix were alone able to grow on this sort of medium. So here we have the control plates. First of all, the DNA, and secondly, the cells alone and on neither of these plates has any growth occurred. Now what this experiment establishes is that DNA can be transferred from one kind of cell to another and that it can carry with it information which makes a difference between those two cells. In this case it carries information which enables these cells to make an enzyme which will allow them to make Tryptophan. We can infer from the results on this plate, one more thing about the function of DNA and that is that this information has been inherited, has been passed on from the original cell which acquired the ability to make Tryptophan to all its progeny. If it were not passed on to its progeny we would simply not get colonies of this size. There are too many cells, it would require too many divisions of a single cell to produce that amount of growth, ten to the nine divisions to be precise. And in any case, we can test quite easily whether all the cells in those colonies can make Tryptophan and they can and you ought to know by now how to do that test.