# The diverse microbiologist


TOPFOTO

You might well ask what a microbiologist does. What do we actually do during our working day and why would anyone want to be a microbiologist?

Many people think we spend our time staring down a microscope, looking at 'bugs'. And they would be right, although only a fraction of the working day is spent identifying 'bugs' under a microscope.

I work for a medium-sized pharmaceutical company that makes a range of products such as antihistamine, antibiotic and angina tablets, lotion for psoriasis, infantile cholic liquid and liquid enemas. Several departments are necessary for the success of the company. I work in the microbiology department, which is part of Quality Control.

The Quality Control section is very important to the company. It has two main aspects:

- ensuring that the products made are of the right standard
- trying to see where problems with quality might arise and trying to stop them before they have a chance to do any damage

Quality Control is responsible for making sure that our products are manufactured correctly and safely, and that tests are carried out to the current guidelines. Ultimately we are accountable for the quality of the final product and must guarantee it is 'fit for purpose' (see Box 1).

The aim of this *prospects* column is to bring you information about some of the very different and stimulating careers that can develop from an interest in the biological sciences.

## Checking the surroundings and materials

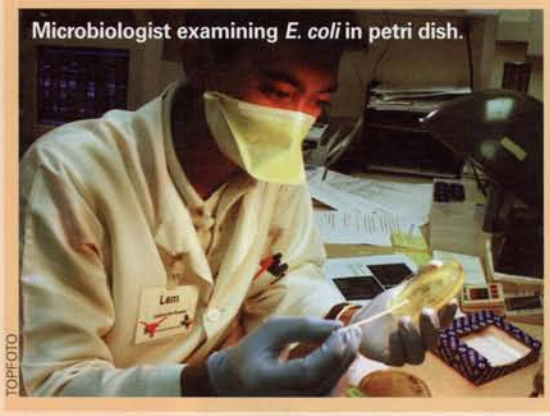
The microbiology department has three laboratory technicians and me. A large proportion of our time involves monitoring the company environment and our products. Figure 1 on p. 40 shows an outline of all the stages in the manufacture of a drug — each of which we have to check.

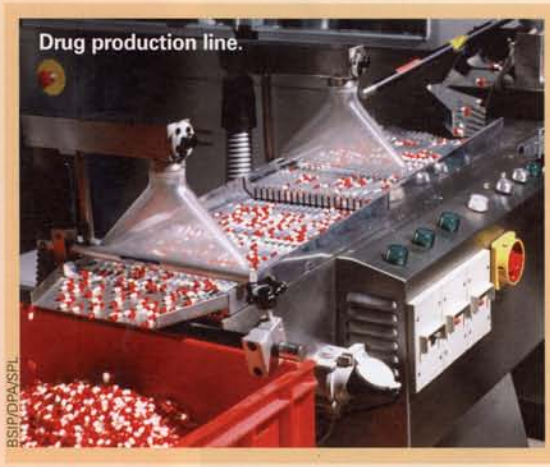
We monitor every stage of the product throughout its journey through the factory for its **microorganismal integrity** to ensure that it is 'fit for purpose' The checking process generally starts with raw materials (the ingredients). These usually arrive from our suppliers in large drums or bags. We sample a representative number of containers, and test the contents for bacteria and other microorganisms. If we are satisfied that all is OK, we 'pass' the materials, they are sent to the manufacturing department and a batch of product can be made. If the materials do not meet the requirements, they are retested. If they still fail, further actions will be taken, and the materials may possibly be discarded.

## BOX 1 Rules and regulations

All pharmaceutical companies have a legal responsibility to work within specific guidelines to ensure the safety of any products. After all, you wouldn't want to end up with a worse condition than the one you started with as a result of taking your medication. To try to prevent accidental harm to patients, there is a whole range of rules and regulations that affect my role. For example, there are guidelines that must be followed during the manufacture of any pharmaceutical product. These cover such things as the type of quality systems that must be used and how these can be established to ensure processes are controlled. The standards are applied throughout Europe; in the USA they follow similar rules, known as the Code of Federal Regulations. Part of my job involves knowing what regulations must be followed, and doing the necessary paperwork to show that everything has been done properly.

Our testing methods are also strictly regulated. The methods we use in the UK and Europe are laid out in a pharmacopeia, known as the 'EP'. We use specifications and standard operating procedures (SOPs) that enable us to determine whether what we find through our working methods is acceptable. If it is not, we have to decide on a course of action — whether to retest, resample or reject. As a microbiologist, one of the obvious things that I am checking is to make sure that the products are not contaminated by any unwanted 'bugs'.





**Quality control using a Coulter counter, a device that counts cells.**

SAMPLING RAW MATERIALS

TESTING RAW MATERIALS

DISPENSING RAW MATERIALS FOR USE

MANUFACTURE PRODUCT

SAMPLING AND TESTING BULK PRODUCT

FILLING PRODUCT

SAMPLING AND TESTING FINISHED PRODUCT

ANALYSE RESULTS


**Autoclave used for sterile production of injectable drugs.**


**Drug capsule inspection.**

***Figure 1*** **Stages in drug manufacture that are checked by microbiologists.**

Our most common raw material is water. This is probably the largest source of microorganismal contamination, so in an attempt to control this, most pharmaceutical companies use a deionised or purified water system, which treats mains water and purifies it further. Although the water from ordinary taps is safe to drink, it contains a large amount of chlorine. We do not want chlorine in our products as it can cause adverse effects, so it must be removed. Unfortunately, removal of the chlorine can allow **biofilm** production, which in turn can cause contamination.

We continually monitor the water system throughout the factory to ensure that the water is of good quality both chemically and microorganismally. We have a total of 15 points in the system where the water is checked. Not all points are checked every day, but there is a regular daily schedule to check for the absence of bacteria.

Water is also crucial because it is used for washing our equipment. The water quality we expect to achieve within our system is less than 1 colony-forming unit (cfu) per cubic centimetre, although current UK guidelines only require a maximum of 100 cfu $cm^{-3}$, so our quality levels are very high. The organism we are looking out for is *Pseudomonas aeruginosa*, as this is an **opportunistic pathogen**.

Environmental monitoring of all critical areas is done every week. Areas and surfaces such as filling machines that come into contact with the product itself, washbays and even floors, are checked. The air quality is checked. The areas where the product is made and put into containers are confined environments — the air in these areas is controlled by a filtered air system. We use air samplers to see whether the environment is clean. The samplers drag a known volume of air across an agar

plate. If there are any bacteria or fungi within this, they stick to the surface of the plate, so when incubated they will grow. We then count and identify them. We also use contact plates to press onto flat surfaces, which will collect bacteria and fungal spores.

## Product testing

Depending upon the product, we are usually looking to show the absence of opportunistic pathogens such as *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans*. We use large volumes of media, such as agar, for growing any microorganisms that we might find. Before we can use the media, however, we have to check its productivity — something you might not think of. We have to take samples and add a controlled number of organisms. We need to know that our culture medium is capable of growing any organisms that are picked up by our sampling techniques. Why? Well, if our media were not capable of growing microorganisms, when we used it for our tests, nothing would grow and the product would be passed as suitable. Just what we hoped for...but wrong! Only when the added organisms have grown successfully can the rest of the medium be used for quality control.

Typically the first job of the day is to inspect and read the agar plates that have been incubated over the last 5 days. This involves counting colonies and identifying the organisms.

Once in its final containers, a representative sample of finished product is tested for its microorganismal integrity. We use statistical analysis to work out how many samples should be tested. It is impossible to test everything — if we did, we would have nothing to sell! We test the most vulnerable parts of the filling process, usually the start, middle and end points. This way we can find out at what stage things have gone wrong (which of course they sometimes do) and take the necessary action. Our tests consist mainly of a total viable count for bacteria, using a test for yeast and moulds, and screening for specified pathogens.

## Qualities for being a microbiologist

In addition to managing the microbiology department, I also support other departments, whether it is training operators in procedures or just being in an advisory role. A typical day for me could also involve many other activities, such as report writing, preparing or testing media, supervising staff, meeting with other departments, planning and coordinating work, checking procedures are adhered to and discussing progress.

One of the most fundamental attributes of being a pharmaceutical microbiologist is organisation and attention to detail. You need to be a master of multi-tasking! The role embraces several scientific disciplines, such as statistics, chemistry, biology, physics and even engineering. I sometimes think back to my college days and wish I had worked harder in those subjects that I thought I would no longer require.

There are a number of routes you can take to become a microbiologist, but usually you require a degree in microbiology or another biological science. Many degrees include a sandwich year, which gives students an idea of the work involved. There are four main areas you could work in — the pharmaceutical and food industries, the health service or in a scientific research department. The techniques used in all these areas are similar, though obviously the working environments differ. Only you can decide which route suits you, although quite often your career depends on the opportunities presented to you and a certain degree of fate. I was a biomedical scientist deciding whether to work for the NHS or in industry. My first foot in the door was with a pharmaceutical company and the rest is history.

A pharmaceutical microbiologist's role is very diverse. One day is rarely the same as the next and you never quite know what you may be up against. I sometimes think that we all take it for granted that medicines will only do what they were intended for and will not harm us. You never think about the processing and considerable testing that has gone into producing that single tablet or spoonful of medicine.

I was certainly not aware that the career I had chosen would be this interesting, challenging and rewarding. In reality, it is a bonus when you enjoy your job, as you are involved 8 hours a day, week in week out. Being a pharmaceutical microbiologist is never dull and you certainly will not be sitting behind a microscope all day. You have to be people orientated, keep your eyes and ears open, liaise with a multidisciplinary team who will and can ask anything of you at any time. You need to be a master of diplomacy, who can be assertive but tactful. The learning goes on every day!

**Sara Gull** is a Pharmaceutical Microbiologist and has been working for Forest Laboratories UK Ltd for the last 7 years.

## TERMS explained

**Biofilm** Microorganisms growing attached to a surface.

**Microorganismal integrity** We only manufacture non-sterile products on our site. Our specifications tell us which contaminants are allowed, how much and what kinds. We do find some bacteria, but as long as the regulations are met, this is not a problem. If we were manufacturing sterile products we would not be allowed to find *any* bacterial contamination. 'Microorganismal integrity' ensures that there are no harmful microorganisms present in the product.

**Opportunistic pathogen** A microorganism that is normally harmless to a healthy person but when someone who is ill is exposed to it, it infects them and causes further disease. For example, pneumonia can be caused by both bacteria and viruses; it is usually found in people who are already suffering from some other condition.

## Further reading

High, N. (2000) 'Bacteria can count!', Biological Sciences Review, Vol. 13, No. 2, pp. 28–31.

Rules and Guidance for Pharmaceutical Manufacturers and Distributors (2002). Medicines Control Agency.

Website: **www.Pharmig.org.uk**