

Did you know?

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Only a small number of pathologists investigate suspicious deaths. Most of the 6,000 pathologists and 20,000 scientists in the UK work for the benefit of the living

Cervical cancer in the UK fell by 42% when screening was introduced

Colds and flu are caused by viruses and cannot be treated by antibiotics

700 people die every year waiting for a kidney transplant because there are not enough organs available

Humans have 20,000–25,000 genes

Many of the drugs used to treat heart disease in animals are identical to those used to treat humans

Every year, about 2 million units of donated blood are transfused in the UK

By 2025, it is estimated that 5 million people will have diabetes in the UK

All these facts relate to pathology. Find out more inside.



The Royal College of Pathologists
Pathology: the science behind the cure

What is pathology?



Pathology: The science behind the cure

www.rcpath.org

What is pathology?

Pathology is at the heart of modern healthcare, involved in over 70% of all diagnoses. Pathologists and scientists are involved in **preventing, diagnosing, treating** and **monitoring** diseases to keep people as healthy as possible.

Pathologists are involved in the diagnosis of disorders affecting **every organ** of the body, and from before birth to after death. The majority of tests requested by your doctor will be performed and interpreted by a pathologist.

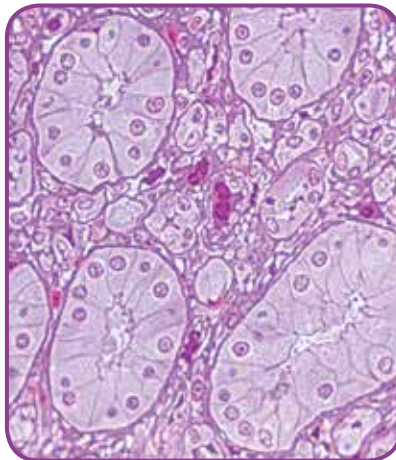


Without pathologists, there would be no way of monitoring how organs such as your liver and kidneys are working. If you went to see your doctor with a lump, they would have no way of knowing what it was without a pathologist. Doctors would be unable to prevent mothers passing on diseases to their babies and wouldn't know if babies had potentially treatable inherited diseases until it was too late.

There would be no way of picking up **cancer** at an early stage when it could be treated. Your doctor wouldn't know which **antibiotic** to prescribe when you had an infection or even whether an antibiotic should be prescribed at all.



Did you know, pathologists perform almost 900 million tests each year in the UK?



Dispelling the myth

When people think of pathology they often think of dead bodies and solving murders, as frequently shown on television. However, this is not very realistic. Only a small number of pathologists investigate suspicious deaths. Most of the 6,000 pathologists and 20,000 scientists in the UK work in hospitals **for the benefit of the living**, working in 19 different disciplines. If you have ever had a blood test or a biopsy, the result will have been provided by a pathologist.

Pathology specialties

The 19 pathology specialties are:

- Clinical biochemistry
- Clinical cytogenetics
- Clinical embryology
- Cytopathology
- Dermatopathology
- Forensic pathology
- Haematology
- Histocompatibility and immunogenetics
- Histopathology
- Immunology
- Medical microbiology
- Metabolic medicine
- Molecular genetics
- Neuropathology
- Paediatric and perinatal pathology
- Toxicology
- Transfusion medicine
- Veterinary pathology
- Virology

Read on to find out more about some of these specialties and the crucial work carried out by pathologists.



Pathology is involved in 70% of all diagnoses in the NHS



Testing, testing...

Every day, pathologists carry out countless **routine tests and investigations** behind the scenes. Without the detective work of pathologists investigating disease, there would be no firm answers and improving or even maintaining the quality of healthcare would be impossible. Pathologists also carry out tests on healthy individuals to identify the risk of developing a future disease, for example, through national screening programmes.



Cancer screening involves testing large groups of the population before symptoms appear. The aim is to identify cancer at an early stage so that it can be treated. In general, the earlier a cancer is diagnosed, the more likely the person is to be cured.

There are several cancer screening programmes in the UK, including:

- cervical cancer screening (smear tests)
- breast cancer screening (mammograms)
- bowel cancer screening (tests for blood in the faeces).

Screening tests are never perfect so there will always be a small number of people who do have a disease but test negative (false negative) and some who test positive when they don't have the disease (false positive). Pathologists and scientists are involved in all the screening programmes.



Cervical cancer in the UK fell by 42% when screening was introduced

Routine tests are carried out on babies to identify the 3-4% who have a genetic disease or birth defect. A small drop of blood is taken from a newborn baby's heel, collected on a neonatal blood spot card, dried and sent for further analysis.

Diseases tested for include:

- **sickle cell disease (SCD)**: 1 in 9,000 babies are born in the UK with this disorder, where red blood cells are sickle-shaped and can block the blood vessels.
- **phenylketonuria (PKU)**: 1 in 10,000 babies in the UK has PKU, where they cannot process phenylalanine in their food. This can cause irreversible mental disability.
- **cystic fibrosis (CF)**: 1 in 2,500 babies born in the UK has CF, where the lungs and digestive tract are affected, and babies fail to gain weight and are susceptible to chest infections.

Understanding living tissue

Histopathology is the study of disease in **tissue** (for example, your body organs).

How do histopathologists find out what's wrong with you? First, your doctor removes a small piece of tissue. This is called a biopsy. The amount of tissue removed varies: it may be smaller than a grain of rice, or as big as a football!

Histopathologists are doctors who examine the tissue carefully under a microscope with a trained eye, looking for changes in cells that might explain what is causing the illness.



Nearly 20 million histology slides are examined in the UK each year

We all love going on holiday, and one of the things we might look for in a holiday is plenty of sunshine. While some sun is good for you, too much can seriously damage your skin. Malignant melanoma, the most serious form of **skin cancer**, is more common in people who sunbathe, particularly if they have fair skin. Pathologists often examine moles under the microscope to find out whether they are benign (nothing to worry about) or malignant (cancerous, with the potential to spread to other parts of the body). Wearing sun cream and avoiding the hot midday sun can help reduce the risk of skin cancer.



Sian's story

Sian noticed a dark mole on her upper arm. At first she didn't worry, but the mole began to itch and get bigger. She showed her doctor, who sent her to a dermatology clinic. The dermatologist removed the mole and sent it to the histopathology laboratory. It was sampled, processed and stained. The microscope slides were examined by a histopathologist. She said, 'Sian did the right thing going to the doctor, since her mole was turning into a form of cancer called a malignant melanoma. This aggressive tumour can spread to other parts of the body, usually with fatal consequences. Fortunately, Sian's tumour was at an early stage, meaning there was little risk of spread and removal was likely to be curative. Because of our report, her doctor knew that no further treatment was necessary and was able to reassure her. Eight years later, Sian is alive and well.'

Blood counts



Jacob's story

The first signs of Jacob being unwell appeared when he was 7, when he got infections and pain in his legs. His symptoms worsened and a blood test showed something was seriously wrong. Jacob was referred to a haematologist, who admitted him to hospital and ordered a bone marrow biopsy. The biopsy results showed that Jacob had acute lymphoblastic leukemia (ALL).

ALL is the most common form of childhood leukemia. It occurs when immature white blood cells, called lymphoid cells, transform and multiply in an uncontrolled way. Chemotherapy treatment is given in several stages and usually lasts up to two or three years. Due to the quick diagnosis, Jacob started therapy almost immediately. He responded well and was back at school and his football lessons when only halfway through his treatment. He is expected to make a full recovery and will only need to go back to hospital if he gets ill or picks up an infection.

Haematologists are pathologists who study blood and bone marrow. Haematologists also measure how well the **blood clots**, and treat clotting problems.

The main constituents of blood are:

- red blood cells – carry oxygen around the body
- white blood cells – help fight infection
- platelets – involved in blood clotting.



Photo credit: NHS Blood and Transplant

Haematologists also diagnose and treat patients with **anaemia** (a lower than normal number of red blood cells) and help patients with **haemophilia**, **leukaemia** and **lymphoma**.

Some haematologists are involved in transfusion medicine, ensuring that adequate stocks of safe blood are available when needed for **blood transfusions**. For example, if you had lost a lot of blood following childbirth or an accident, or have a blood disease, you would need new blood from a donor. Blood transfusions can be life saving in these situations. Pathologists ensure blood transfusions are safe. They confirm donated blood is the right match for the patient's blood group. This is important because, if you receive blood from a different blood group from your own, your body will reject the new blood, which can prove fatal.

Haematologists also undertake **research** into diseases, like leukaemia. By gaining understanding of diseases they can also research therapies to help improve survival rates of patients.

Cause of death?

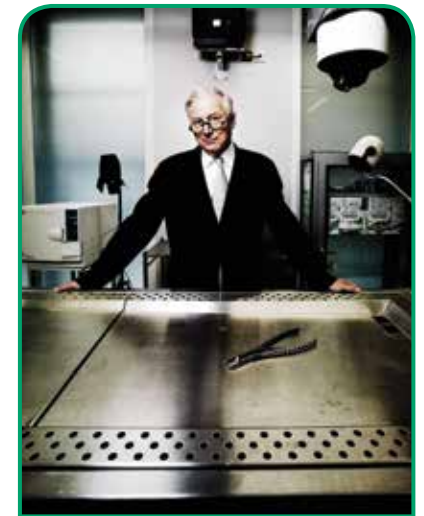
Many people learn about pathology from television programmes such as *Silent Witness* and *CSI*. Although this is a branch of pathology that many people have heard of, **forensic pathology** is actually one of the smallest specialties, accounting for less than 1% of pathologists.

Forensic pathologists study deaths that are considered to be a result of crime. Forensic pathologists often give evidence in court, for example, in murder trials.



Most sudden and unexpected deaths in the UK, especially the deaths of older people, are due to natural causes such as a heart attack or stroke. Sometimes the cause of death is not known, usually because the person had not recently seen a doctor. Around 20% of people have an autopsy (also called a post mortem) after their death. These are usually performed by **histopathologists** working in hospitals.

There are two types of post-mortem (PM): a coroner's PM (when cause of death is unknown or after a violent or unexpected death) and a hospital PM (to find out more about an illness or cause of death, or to further medical research). Both are very similar to a surgical operation and are carried out in a respectful manner, with regard to the feelings of the relatives.



121,000 autopsies are carried out each year in the UK



Battling the bugs

Medical microbiologists are pathologists who diagnose and treat infectious diseases. They study pathogens: organisms that cause disease, such as **viruses, fungi or bacteria**.

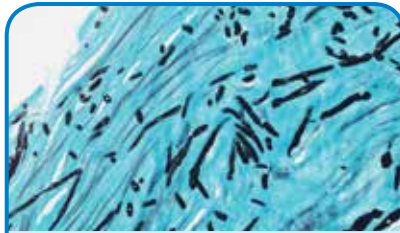
Microbiologists perform tests to find out which antibiotics will be most useful in stopping an infection. Different bacteria are sensitive to different antibiotics, so pathologists ensure the correct antibiotic is prescribed. Microbiologists also play an important role in **infection control**, preventing infection passing from one patient to another in hospitals and the community.

Antibiotics are drugs used to treat bacterial infections. Antibiotics don't work against viruses so are no help if you've got a cold or flu. Taking antibiotics unnecessarily can result in bacteria becoming resistant to the antibiotic. This means that the antibiotic won't work when it is needed. Antibiotics take several days to work properly. It is important to take the entire course of antibiotics even if you feel better – or bacteria not destroyed by the initial dose might continue to grow.

Many of the most common infections are caused by viruses and bacteria.

Viral diseases include: common cold, influenza, hepatitis B and HIV/AIDS.

Bacterial diseases include: tuberculosis, salmonella (food poisoning), tetanus and chlamydia.



Kasia's story

Kasia, who wore contact lenses, had returned from holiday. Her right eye was painful and her vision was blurred. Her doctor thought she had an infected cornea (the transparent front of the eye) and gave her antibiotic eye drops. However, after a month, things were no better so her doctor took some samples from the cornea. They were sent to histopathology and microbiology laboratories for analysis.

Histopathologists looked at thin slices of tissue down the microscope and saw not bacteria, but fungi. The microbiologists grew the fungus in their lab and its appearance suggested *Fusarium*. They changed Kasia's treatment so it was effective against fungi, rather than bacteria. Thankfully Kasia's condition improved – but if the infection had spread too far, she may have needed her whole cornea removed in a surgical procedure requiring corneal transplantation. If you wear contact lenses, you are advised to follow the cleaning instructions and avoid extended wear.

Mothers and babies

From IVF for couples having trouble conceiving, to a test on the newborn baby, **pathologists are involved at most stages of a baby's journey**. Pregnancy isn't an illness but pathology plays an important role in ensuring that mothers-to-be and their babies remain healthy. Expectant mothers are offered a range of pathology tests including finding out their blood group (in case a transfusion is needed), hepatitis B and HIV/AIDS (to make sure these are not passed onto the baby) and haemoglobin levels (to check for anaemia).

Pregnant women are also advised to avoid certain foods such as unpasteurised cheese, pâté and raw eggs. This is because these foods may contain bacteria that could harm the baby. Pregnant women are advised to have both flu and whooping cough vaccines in pregnancy. Vaccinations are developed by virologists and immunologists (branches of pathology).

Newborn babies as well as babies in the womb are tested for serious diseases so that they can be treated before irreversible damage occurs.



As recently as the 1950s, pregnancy tests involved injecting urine into frogs



Over 13,000 babies are born following IVF in the UK each year

Paediatric pathology is the study of the diseases of fetuses and babies. Over 4,500 babies are born with congenital heart disease in the UK each year, the most common kind of birth defect. Thanks to research on congenital heart disease and the development of new treatments, over 80% of babies born with the condition now survive to adulthood.

Defending the body

Ravi's story

Each year, 700 people die waiting for a kidney transplant as there are not enough organs available. The introduction of 'altruistic donation', where a person donates a kidney to someone they do not know, has helped to expand the pool of potential donors.

Ravi was 6 when his kidneys stopped working properly. He needed dialysis for 11 hours every night, which was incredibly restricting. After five years of dialysis, Ravi was matched with a kidney from an altruistic donor. Before the transplant could take place, tests were undertaken in a histocompatibility and immunogenetics (H&I) laboratory to ensure the kidney was compatible. Ravi's tissue type and his donor's were confirmed to ensure there was a good match. Ravi and his donor were also 'crossmatched' – a laboratory test that mimics the effects of the transplant. This is critical to ensure the kidney is not rejected as soon as it is transplanted. The test results meant the transplant could proceed.

The new kidney transformed Ravi's life. Within a year, Ravi was able to go on sleepovers and holidays – all things that were impossible during his dialysis. Ravi said: "Life is so much better in so many ways – I'm so very grateful to my amazing donor".

During the Second World War, **immunologists** discovered that skin grafts (the transplantation of skin) given to soldiers failed to 'take' properly. The soldiers' immune systems were treating the transplanted skin as foreign 'enemy' material.

Studies of the immune system enabled immunologists to improve the transplant process so that they now have a better chance of success.



Photo credit: NHS Blood and Transplant

Over 3,500 heart transplants are carried out each year

Immunologists are pathologists who run the specialist laboratories that provide testing for immunological disorders. For example, they perform tests for people with autoimmune disorders, immune deficiency and **allergies**. Immunologists play an important role in looking after patients who receive **organ transplants**.

Immunologists help find out whether patients are likely to reject a transplant and try to minimise the risk. In order to help organ transplants work, immunologists make sure that the donated organ or tissue is as close a match as possible for the patient.

Animal matters

Veterinary pathologists study pathology in animals. Veterinary pathologists first train as vets and then specialise in one or more pathology disciplines. They work with animals in zoos and farms as well as people's pets.



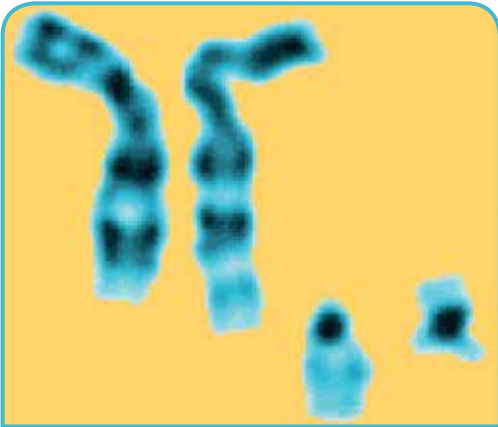
Just like people, animals can get ill with many different types of disease. Veterinary pathologists have to know about how the different organs of different animals work, and test for many of the same conditions that pathologists check for in humans. For example, veterinary pathologists might check an animal's blood pressure, whether the animal has any poisons or drugs in its body, or whether the animal has an infection or tumour. Like other pathologists, veterinary pathologists work more with live animals than with dead ones. Once veterinary pathologists have diagnosed a disease they will often carry out further tests to create a treatment and management plan.

Some veterinary pathologists work for the Animal Health and Veterinary Laboratories Agency (AHVLA). They are responsible for establishing the cause of disease and monitoring emerging diseases in large herds and flocks to ensure that food animals (i.e. the animals we eat) are free from infection.



Many of the drugs used to treat heart disease in animals are identical to those used to treat humans

It's all in the chromosomes



There are more than 6,000 known genetic diseases

Eve's story

Eve, 38, was bleeding between her periods and was referred for a biopsy. A histopathologist examined the sample and diagnosed endometrial cancer: cancer of the lining of the womb. Eve wondered why she had cancer at a young age. She knew her father had died from bowel cancer at 52 and was worried to learn that her father's aunt had also died from womb cancer aged 45. So Eve's GP referred her to the genetics service, which confirmed her family history through the records of the local cancer registry.

The geneticist explained that the cancers might be due to an inherited condition called Lynch Syndrome and extra tests were needed to be sure. If they could find the genetic mutation, then Eve's relatives could be tested too and they would know if they needed extra screening. Eve agreed and the genetics laboratory tested DNA from her cancer, which supported extra tests by the pathology laboratory. The genetics laboratory found a change in Eve's DNA, which confirmed she had Lynch Syndrome. Eve's sister was also found to have the gene. The diagnosis meant the family could undergo additional screening and be reassured that the risks of illness from any future cancers are reduced.

Chromosomes are made up of DNA (deoxyribonucleic acid) and provide the blueprint to build every cell in the body. A length of DNA that provides the code for a protein is called a gene.

Genes determine characteristics such as eye and hair colour. Genes can also be responsible for genetic diseases, which can be passed from parents to child. An abnormality in a gene can result in faulty proteins being created which can cause disease.

Geneticists are pathologists who study how diseases such as sickle cell anaemia and cystic fibrosis are inherited. They help patients and their families with accurate testing and prenatal diagnosis, which they can use to make critical choices about their lives and the planning of their families. New tests are appearing every day, largely because of the Human Genome Project, the sequencing of the entire human genome, which was completed in 2003.

Drugs and poisons

Toxicologists are pathologists who study drugs and poisons and their effect on the body. They test many different kinds of human specimens, like blood, urine or body organs, to try to find out what drugs or poisons someone might have taken.

When people are poisoned or take drugs, this can have a serious effect on the heart. Drugs and poisons can affect the heart's rhythm by speeding it up or slowing it down.

Over time, this can damage the heart muscle and valves, which stop the heart being able to pump blood properly.



One drug that damages the heart is **alcohol**. Drinking a lot can cause high blood pressure and disrupt the rhythm of your heart. Over many years, drinking alcohol can increase your risk of heart failure.

Every year alcohol causes around 4% of cancer cases in the UK, affecting about 12,500 people

Pathologists also test thousands of urine and blood samples for **banned substances** during large sporting events such as the Olympics.



A strand of hair can provide a timeline of the drugs in our bodies



Chemicals in the body

Many illnesses are the direct result of a disturbance in the body's chemistry. **Clinical biochemists** are pathology professionals who study the chemicals in the blood and other body fluids (like urine). By measuring the levels of different chemicals, pathologists and scientists can diagnose diseases and recommend treatment.

Diseases have many causes, some of which, such as inherited disorders, we have no control over. One of the main areas where we can influence whether we develop disease is in our diet. Many diseases are linked to eating or drinking too much of the wrong thing (or not enough of the right thing). As advances in medicine mean that people are living longer, looking after our bodies has become even more important. Our diet and exercise habits throughout our lives can have a huge impact on how healthy we are in old age.

In **heart disease**, there are several chemicals that might be increased. One of the most important is cholesterol, a type of fat present in the blood. If cholesterol levels are too high, there is an increased risk of having a heart attack. Clinical biochemists measure cholesterol and give advice about how to lower it to normal levels.

Diabetes is another disease that is often diagnosed and managed by clinical biochemists, monitoring the level of glucose and other substances in the blood.

Glucose is a sugar that provides fuel for the body. The blood glucose level is regulated by the hormone, insulin. If the body doesn't produce enough insulin, **diabetes** may develop. Diabetes can cause eye and kidney disease, and can cause blood vessels to narrow, resulting in heart disease and poor circulation. Some women develop diabetes during pregnancy.



Peter's story

Peter, a previously energetic 47 year old, couldn't understand why he felt increasingly thirsty and tired, and passed more urine than usual. His GP suspected diabetes and sent a fasting blood sugar test to the clinical biochemistry laboratory. The lab found a raised blood sugar level and advised the GP to repeat the investigation and check his glycated haemoglobin to confirm the diagnosis of diabetes mellitus.

Once the diagnosis was confirmed, the laboratory advised the GP to arrange further investigations to check kidney function and cholesterol level. Three early-morning urine specimens were checked for protein, to see if there was any evidence of diabetes affecting the kidneys, and the GP arranged for retinal photography to check Peter's eyes for evidence of diabetes. Peter was then able to start anti-diabetic therapy, which quickly improved his symptoms.

The Royal College of Pathologists

The Royal College of Pathologists is a professional membership organisation committed to setting and maintaining professional standards and to promoting excellence in the teaching and practice of pathology, for the benefit of patients. It is a registered charity and has over 10,000 members working in hospital laboratories, universities and industry worldwide. Members include medically qualified pathologists as well as clinical and biomedical scientists, all working together to prevent, diagnose and treat disease.

This booklet has given just a few examples of how pathology contributes to modern healthcare. Other important contributions include:

- vaccinations against serious infections
- diagnosis and treatment of allergies
- investigation of sudden infant death syndrome
- diagnosis and treatment of skin conditions
- investigation of diseases of the nervous system.



National Pathology Week is organised by The Royal College of Pathologists to highlight the central role of pathology in everyone's healthcare.

There are many rewarding careers in pathology, either as a doctor or scientist. **National Pathology Week** is a great opportunity to meet pathology professionals and find out what they do.



Careers in pathology

To work in pathology you can attend medical school and then specialise in pathology, but you don't have to be a doctor to work in pathology. Pathology offers a range of other career options. For example, you can train as a clinical scientist, biomedical scientist or as a laboratory assistant.

To find out more about careers in pathology visit:
www.ilovepathology.org/what-is-pathology/Careers

For more information about pathology, careers and National Pathology Week visit:
www.ilovepathology.org