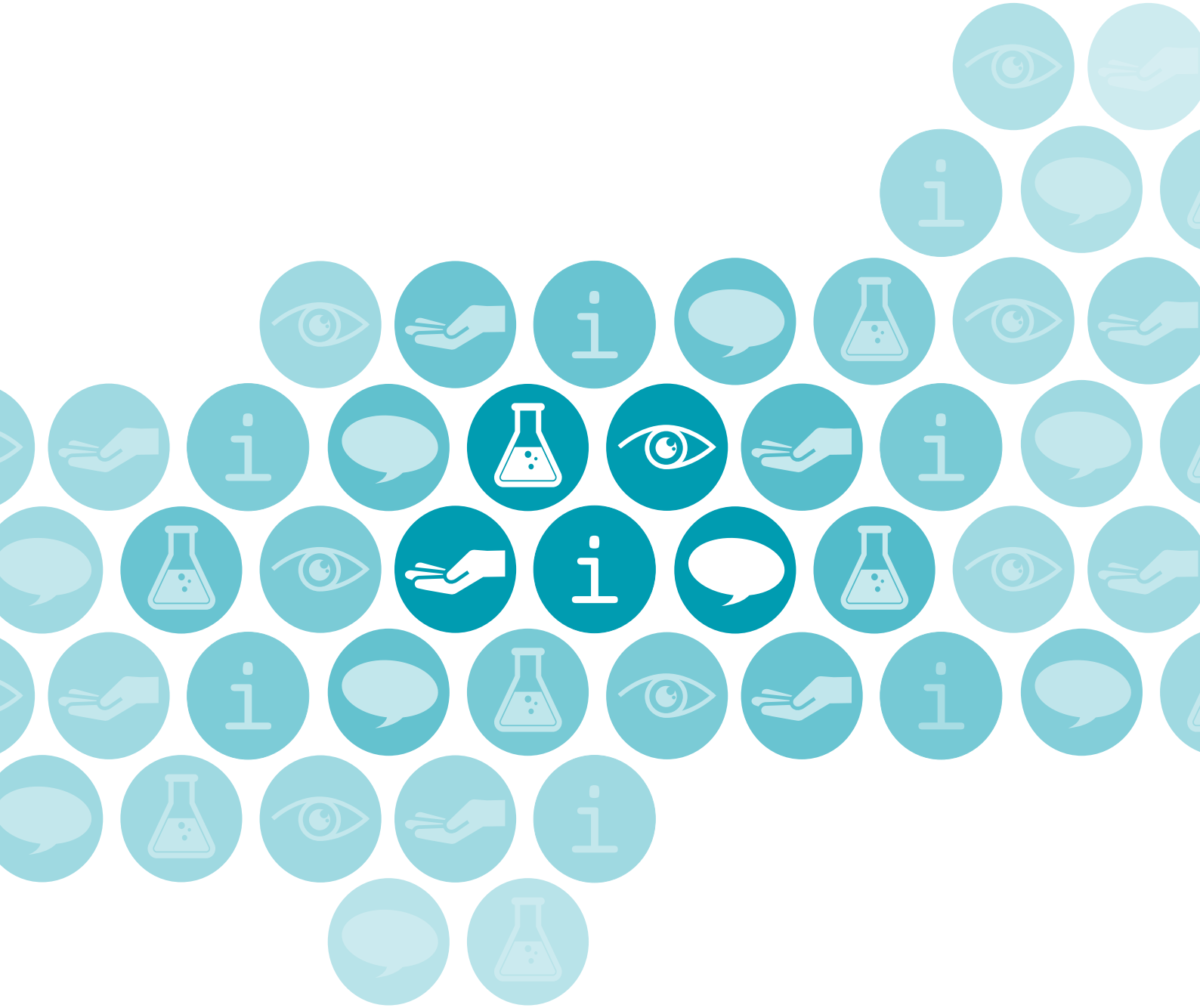
The Royal College of Pathologists
Pathology: the science behind the cure



WHAT DOES YOUR POO SAY ABOUT YOU?

RESOURCE PACK

Contents

This set of activities aims to show the general public how pathologists look for early signs of disease on the inside by testing what comes out! The four different activities give people the chance to find out what poo really is, and get hands-on with fake poo and 'FOB' test cards as way of understanding how the real 'poo-in-the-post' cards have been used to screen older people for early signs of bowel cancer. The final activity using magnetic sheets will demonstrate how a new more accurate 'FIT' test works, and how it is making bowel screening easier for both patients and health professionals.

What happens in digestion?

Show Hand Out Fact Test Ask/Discuss

Learning objectives

This is an introduction to the digestive system and offers a starting point for those delivering any/ all of the other activities below.

Audience

Minimum age is likely to be 4.

Equipment

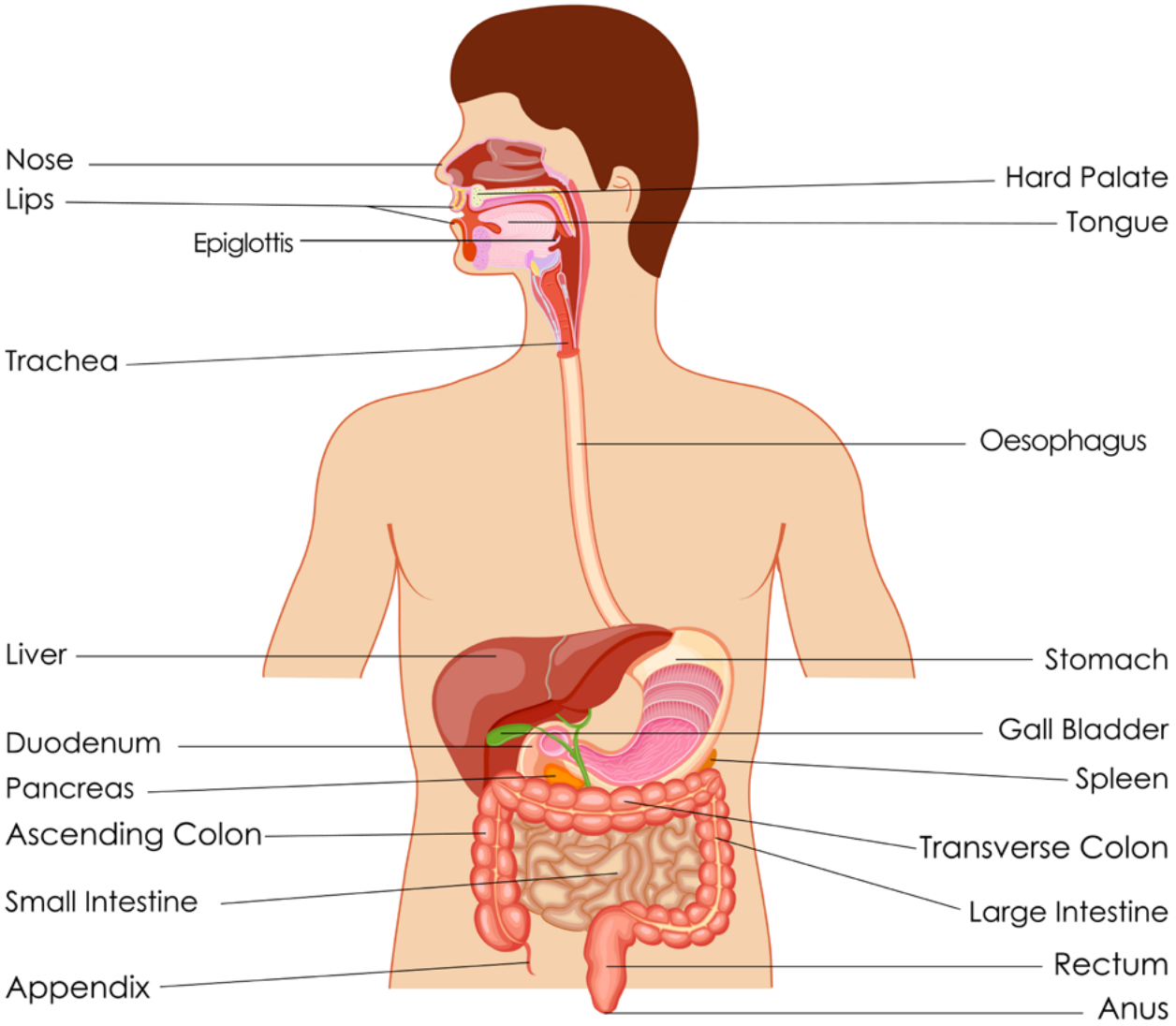
A laminated picture of the digestive system shown below which can be downloaded from the same page as this pack.

Duration

Approximately 5 - 10 minutes.

Instructions

Talk through the stages of digestion. You can add in questions such as those suggested below, rather than just talk participants through the process.



Where does digestion start?

Digestion starts in the mouth. You put food in your mouth and your teeth breaks it all up into small pieces to be swallowed.

Saliva is produced in the **salivary glands** underneath your tongue and in your jaws. This waters down the food particles and contains **amylase**, an **enzyme**, which breaks down **starch**. The tongue mixes the food and saliva together to make it into a **bolus** (ball), which is easy to swallow.

What happens to food when you've swallowed it?

The **oesophagus** is a tube that gets our food from our mouth to our **stomach**. A small flap called the **epiglottis** stops food from accidentally going down the windpipe to our lungs.

The food gets to the stomach where **gastric juices**, the enzyme **pepsin**, and the acidic pH (thanks to **hydrochloric acid**) break the food down further, turning all the food into **chyme**.

How long do you think food stays in the stomach for?

This process takes 3-4 hours. But the **nutrients** ('the good stuff') still haven't yet made it into the **bloodstream**.

Have you heard of bile before?

As the stomach opens up into the **small intestine**, more chemicals flow in. **Bile**, a green liquid, made in the **liver** and stored in the **gall bladder** comes in, to break down **fats**. The **pancreas** releases **pancreatic juice** that contains **sodium bicarbonate** (neutralises the stomach acid), salt and digestive enzymes to break down **proteins** and starch.

Why do you think the small intestine is so long?

The small intestine is the longest part of the digestive system – its length gives the maximum chance for all of the nutrients to be absorbed through the tiny hair-like villi in the intestine wall. The villi further increase the **surface area**, into the body's bloodstream.

The **large intestine** removes a lot of the water, and all that is left is anything that the body can't digest.

Why do you think the water has to be removed at this stage?

These 'leftovers' spend around 12 hours in the large intestine, slowly becoming **faeces** (poo!) in the **rectum**. The rectum is a storage space for faeces, which leaves the body through the **anus**... your bottom!

Pom pom peristalsis

Learning objectives

This is a simple activity to explain the process of **peristalsis**.
It was developed by The Physiological Society.

Audience

A minimum age of 5 is advised for this activity. It works with both primary and secondary school groups in a timed classroom session, and with mixed audiences at drop-in events like festivals.

Equipment

- Transparent plastic bag tube (see www.polybags.co.uk)
- 4.50cm fluffy pompoms (from craft supply stores or search online)

Duration

Approximately 5 - 10 minutes.

How to explain digestion

After you eat, it takes about six to eight hours for food to pass through your stomach and small intestine. Food then enters your large intestine (colon) for more digestion, absorption of water and, finally, getting rid of undigested food (poo!).

Food moves through digestive system by a process known as **peristalsis**: the wave-like squeezing of two sets of smooth muscles in the walls of the gut. One set runs along the gut, while the other set circles it. These muscles create a squeezing action, moving food down the gut. Peristalsis begins in the **oesophagus** when food is swallowed. The strong wave-like movement carries the food to the **stomach**, where it turns into a liquid called **chyme**. Peristalsis continues in the small intestine where it mixes and moves the chyme back and forth, and nutrients are absorbed into the bloodstream through the **small intestine** walls.

Peristalsis ends in the **large intestine** where water from the undigested food is absorbed into the bloodstream. Finally, the remaining waste products: faeces (poo!) is excreted from the body through the **rectum** and **anus**.

Did you know?

'Food to poo' can take 24-72 hours.

A little bit pooey

Learning objectives

- Learning about our digestive system and what happens to waste material;
- Understanding that when we are not healthy on the inside we can test what comes outside to diagnose disease;
- Understanding how the faecal occult blood (FOB) test works;
- Learning to question and discuss issues that may affect our own health and lives.

Audience

Anyone aged 4+ although adjust level of detail you give depending on age.

Equipment

- Potato or horseradish (see below)
- Instant porridge flakes (e.g. Ready Brek)
- Cocoa powder
- Water
- Food processor (not required if you use ready-creamed horseradish - see below)
- Sample tubes or plastic shot glasses
- FOB cards (enough for 2-3 per pair - these can be obtained from Alpha Labs using button below)

FOB cards

- Box of safety gloves (for handling reagent)
- Lolly sticks or similar if the FOB card kits don't have them included
- Developing reagent. (Which can be obtained from Alpha Labs using button below: consists of hydrogen peroxide and ethanol)

Developing reagent

How to prepare the pretend poo

Make up some pretend patient stool samples using some raw potato or horseradish that has been chopped into pieces and liquidised or blended to a purée, you can also use creamed horseradish bought in a jar. Mix with some dark cocoa powder to resemble faeces. Add small amounts into sample tubes or plastic shot glasses. These samples will give a positive FOB test result.

Make up some pretend stool samples similar to the above, that will give a negative FOB test result, but this time by mixing up some porridge flakes (e.g. Ready Brek) with some dark cocoa powder and water

Duration

Approximately 30 minutes.

Practical / discussion activities

If a pathologist has been invited, allow them to give a quick background on laboratory testing and their role as a pathologist.

Discuss with the students the digestive system, and what exactly faeces are? What else do we call it (poo, stools)?

A digestive system diagram can be downloaded from the same page as this pack.

Our organs are great at telling us when something is wrong inside, by sending something outside. And pathologists know exactly how to find this out, by testing that something... for example, testing our poo! Poo, or 'faeces', is the undigested food matter that comes out of our bottom. But there is so much more in our poo: bacteria, skin cells, salts, minerals and sometimes even blood. The clues in our poos can tell us if we have a healthy gut...or not.

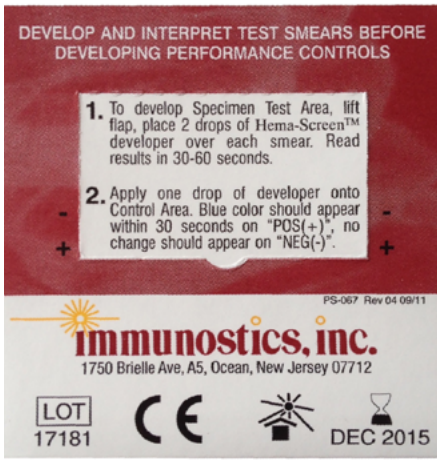
Show students the FOB cards. These are faecal occult blood cards.

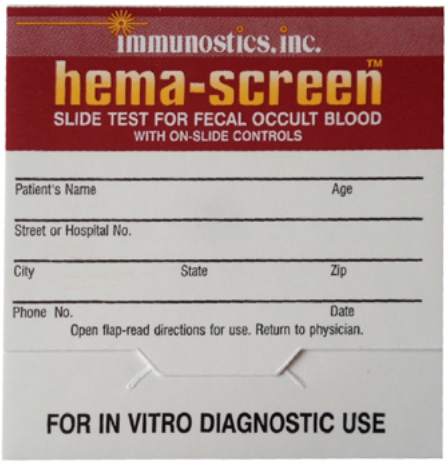
'Faecal' refers to 'faeces' i.e. the waste product from gastrointestinal tract (from mouth all the way down to anus), also known as stools. 'Occult' means 'no obvious symptoms or signs' i.e. the presence of blood in the stools that is not obvious.

Show the students how the cards work.

FOB tests are used to screen for various conditions, but mainly bowel (or colorectal) cancer. It detects the presence of haemoglobin, i.e. blood. Blood found in faeces can be a symptom of early cancer. By detecting cancer early enough, the patient can receive treatments so that the cancer cannot spread, and they can be cured.

For every 100 people tested, only 2 have an abnormal result. And of these, they don't usually have cancer. There are other reasons for gastro-intestinal bleeding, so further tests must always be done.





Ask the students to work in pairs, choose a stool sample, and to pick up a FOB card and an applicator. They can write some pretend 'Patient Details' on the front of the card, and lift up the flap to apply the samples. Using the applicator, ask one student to take a small amount of stool sample and smear it onto the first of the two oval areas. Then repeat, but this time ask them to take another small amount from a different area of the stool sample (i.e from a different pot of pretend poo) and smear lightly onto the second oval area.

They can follow the instructions on the card. Ask the student to close the flap and pass it onto the other student. This student now should turn over the card, peel the 'developing area' section on the back and apply two drops of the developing reagent onto the two areas.

An intense blue colour should occur within seconds if the test is positive (i.e. that there is blood in the stool sample).

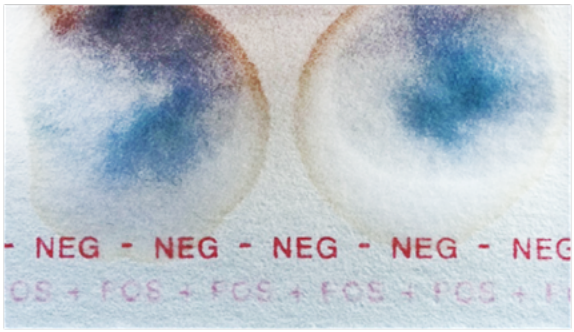
How the test works:

The test paper is covered with a layer of guaiac resin (plant-based material). When the developing reagent (hydrogen peroxide) is added to the guaiac resin, it oxidises it, turning it into a blue coloured quinone.

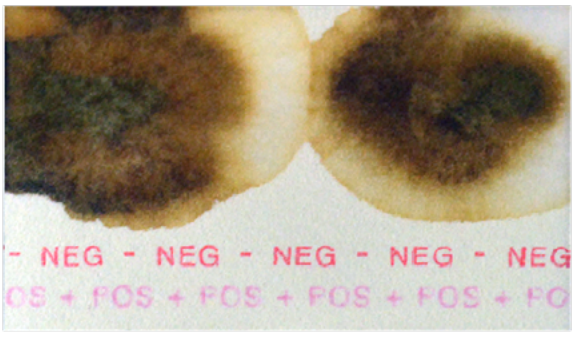
By adding a stool sample, containing haemoglobin, the haem that is present, has a peroxidase-like effect and catalyses the reaction, so the colourless-to-blue reaction happens within seconds.

Guaiac resin + Hydrogen peroxide → **Peroxidase** → **Blue reaction**

Positive



Negative



Discussion

Find out what the participants understand about the test, and whether they can think of ways in which the test may be misleading. Maybe they have heard of horseradish peroxidase before.

False positives can occur when a patient has just eaten red meat within three days of testing, as red meat contains haemoglobin. Also vegetables with a high peroxidase or catalase content: horseradish and potatoes. As well as if the patient has taken any drugs that can cause intestinal bleeding e.g. anticoagulants (blood thinner), steroids.

To try and reduce the chance of these 'false positives', patients are asked to take samples from different parts of the stool for placing on each of the two sample windows. National screening programmes also use a version of the test card that has three flaps with space for providing two samples per day over three different days to reduce the likelihood of dietary effects on results.

This test is gradually being replaced for bowel cancer screening programmes by a more sensitive test known as a faecal immunochemical test ('FIT'), which only detects human blood in the poo. You can find out more about this new test by taking part in the 'A little bit less pooey' activity that has been created by the Royal College of Pathologists.

Useful links

Fecal Occult Blood tests on LabtestsOnline: :

*www.labtestsonline.org.uk/tests/faecal-occult-blood-test-and-faecal-immunochemical-test_*

Bowel (colorectal) cancer:

www.nhs.uk/conditions/Cancer-of-the-colon-rectum-or-bowel/Pages/Introduction.aspx

Bowel cancer screening:

UK Government guide on how to carry out the FOB test:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/423965/kit-instructions.pdf

A little bit less pooey

Learning objectives

To help participants understand that when we are not healthy on the inside we can test what comes outside (such as our faeces) to diagnose disease.

This activity is a simulation of the FIT (Faecal Immunochemical Test), which is replacing the FOB (Faecal Occult Blood) tests, demonstrated in the 'A Little Bit Pooey' activity above. Both activities can be run together to show the differences in the tests.

Audience

Any age, although more suitable for secondary school students. If at an event with under-fives, they must be supervised as many of the items in this activity are choke hazards.

Equipment:

- Box template, to prepare 2-3 x 'Poo Sample' boxes can be downloaded from the same page as this pack, or any available small boxes
- 2-3 x A5 or A4 magnetic sheets
- Plastic or metal trays such as disposable baking tins
- Black paperclips
- A variety of small brown items (e.g. matchsticks, rubber bands, beads, shells, bottle tops, brown paper/card pieces)
- Some example FIT bowel cancer screening kits for display
- Diagram explaining how immunochemical tests work (optional)

Duration

15 minutes, longer if using alongside the 'A Little Bit Pooey' activity with discussion on differences and/or how immunochemical tests work (see below).

Instructions

Make up three Poo Sample boxes, adding a variety of small brown items to each. Into each box add a different number of paperclips:

- Box 1: No paperclips
- Box 2: 8 paperclips
- Box 3: 20 paperclips

Ask participants what they know about the digestive system, and what faeces are? What else do we call it (poo, stools)? Explain that our organs are great at telling us when something is wrong inside, by sending something outside. And pathologists can test that something... for example, testing our poo! Poo, or 'faeces', is the undigested food matter that comes out of our bottom. But there is so much more in our poo: bacteria, skin cells, salts, minerals and sometimes even blood. The clues in our poos can tell us if we have a healthy gut...or not.

Show participants the FIT test equipment and materials, and tell them that 'FIT' stands for: Faecal Immunochemical Test. This test is much more accurate than previous tests in finding out how much blood is in the faeces. FIT detects the presence of human haemoglobin (the oxygen-carrying protein found in red blood cells), whereas the FOB test may indicate a positive result when someone has eaten certain foods such as red meat or horseradish.

Blood found in faeces can be a symptom of early cancer. Colorectal cancer kills 700,000 people a year worldwide, and many deaths could be prevented by screening. By detecting cancer early enough, the patient can receive treatments so that the cancer cannot spread, and they can be cured. There are also other reasons for gastro-intestinal bleeding, so further tests must always be done. People over the age of 60 are asked to take samples of their poo for testing in a lab.

Ask participants to choose a stool sample, and add it onto one of the magnetic sheets. Each sample is 1g of faeces. Then do the same with the others. When they hold up each sheet vertically, they should find only paperclips (human haemoglobin) will remain stuck to the sheet. They can then count up the paperclips to get the number of micrograms of haemoglobin in their sample.

Give them a cut-off-point (i.e. the number of micrograms of haemoglobin per gram of faeces) of 10 micrograms.

If the haemoglobin level exceeds the cut-off-point the patient needs to go for further tests.

If the haemoglobin level is under the cut-off-point the patient need not worry about further tests.

Extending the discussion

You can discuss the advantages of the FIT over FOB:

FIT tests for hidden HUMAN blood, from the lower intestines, in the poo sample. Medicines and food will not affect the results, the way they do in the FOB tests.

FIT also gives a result, a number of micrograms of human haemoglobin contained in each gram of poo. And from that result you can tell more accurately whether further tests (e.g. a colonoscopy – using a fibre optic camera passed up through the anus to examine the intestines in more detail) are needed to check for bowel cancer. Because the FOB test relies on human eyes judging whether there has been a colour change or not, it is much less accurate.

The patient only has to take a sample of their poo from one place on a poo; with FOB they are asked to take three samples from different areas of their poo.

With older secondary students (particularly sixth formers) you can open up longer discussions about the differences between FOB and FIT tests and/or how immunochemical tests like FIT use antibodies that recognise an antigen and specifically bind to them. In the Faecal Immunochemical Test, the antigen is human haemoglobin.

Immunochemical tests provide a much more sensitive testing method, and can be automated for quick analysis in a lab. Antibodies are Y-shaped proteins in our immune system, and can recognise unique foreign targets, known as antigens. Because antibodies bind specifically to certain antigens, you can use this to find out how much of the antigen is present in a sample. This can be measured by creating antibodies with markers, such as fluorescent labels so that the machines in the lab can give an actual value based on the fluorescence: i.e. the more fluorescence, the more antigens.

Useful links

Bowel (colorectal) cancer:

www.nhs.uk/conditions/Cancer-of-the-colon-rectum-or-bowel/Pages/Introduction.aspx

Faecal Immunochemical Test:

https://www.cancerresearchuk.org/health-professional/screening/bowel-screening-evidence-and-resources/faecal-immunochemical-test-fit

How the FIT test is performed:

https://medlineplus.gov/ency/patientinstructions/000704.htm

Faecal Immunochemical Tests introduced:

Useful links to scientific papers with more in-depth information:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5587839/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5454735/