Ideas about Cause of disease & illness c1700-1900

Louis Pasteur

Robert Koch

The age of enlightenment

- The 18th Century was a VERY exciting time in the world of science and medicine. The influence of the Church had all but gone, not many people believed God was responsible for everything.
- Instead they wanted SCIENTIFIC explanations, for everything!

- This enlightenment touched every walk of life, Politics, History, Economics, Philosophy and Science.
- There really was a Scientific Revolution going on
  - Part 1: Renaissance – Challenging ideas
  - Part 2: c1700 replacing old ideas with new and proven ideas
- As you know, cities were also growing rapildly, causing major illness meaning understanding of causes was even more important!

Continuity & Change

Spontaneous Generation

- The Theory of the Four Humours is gone!
- People still believe in Miasma, but it's less popular
- A new theory of SPONTANEOUS GENERATION replaced the Four Humours.
- Microscopes improved with better glass lenses meaning scientists could see microbes present on decaying matter

Spontaneous Generations:

The theory that microbes were the product of decaying matter, rather than the cause of them.

This was wrong, but still progress!

Key words:

Microbe: Any living organism that is too small to see without a microscope. Microbes include Bacteria

Decaying matter: Organic material like vegetables or animals that has died and is rotting

SUPER IMPORTANT

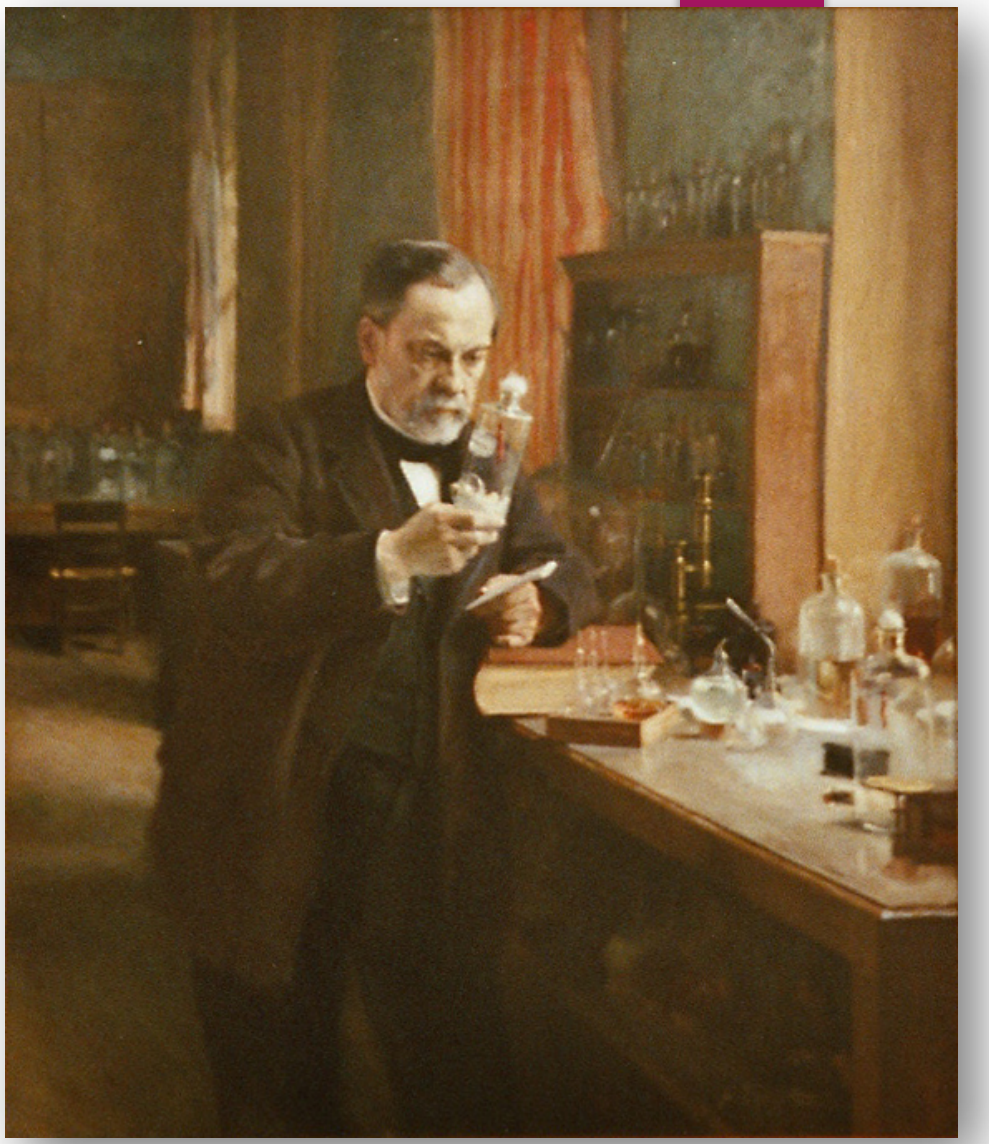
The Germ Theory 1861: Louis Pasteur

- In 1860, the French Academy of Science challenged scientists to come up with EVIDENCE to either prove or disprove the theory of Spontaneous Generation.
- By mid 19th Century, microscopes were so good, it was possible to magnify substances to a much higher level and keep the image to see
- Louis Pasteur was a French SCIENTIST (not a doctor) who was able to observe unwanted microbes in wine and vinegar which turned both liquids bad
- He came up with the Germ Theory in 1861 which FINALLY allowed us to know the cause of illness and disease. It proved that disease in liquids and animals is caused by germs that are already in the air, not just growing spontaneously
- Germ Theory disproved the idea of Spontaneous Generation

Four basic principles of Germ Theory

- The air contains living micro-organisms
- Microbes can be killed by heating them
- Microbes in the air cause decay
- Microbes in the air are not evenly distributed in the air

What can you infer about Pasteur from this image?



What did he discover and how?

THEORY	EXPERIMENT	
The air contains living micro–organisms	He took sterile flasks out into the streets of Paris, opened them briefly, then sealed them again. Bacteria grew in them.	
Microbes are not evenly distributed in the air	He repeated the experiment in various places around France including high mountains. The number of bacteria varied.	
Microbes in the air cause decay	He filled two flasks; one with sterile air and the other with ordinary air. In the first there was no decay; in the second decay proceeded as normal.	
Microbes can be killed by heating	He heated a material in a flask to make it sterile. He drove the air out, then sealed the flask. It remained sterile even 100 years later.	

Stick this in your books and DESCRIBE in your own words, the work of Louis Pasteur

Watch the following clip (1.08-5.08) and write a journalist's report on Pasteur's ideas.

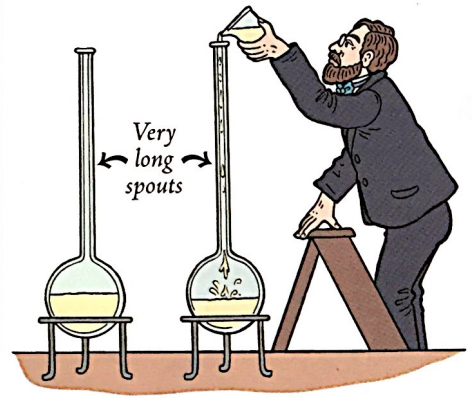
1 In 1857, Pasteur was asked to find out what was making a company's beetroot alcohol turn sour.

He concluded that germs were harming the liquid … and they did the same to milk and beer.

2 Pasteur then looked for ways to solve the problem.

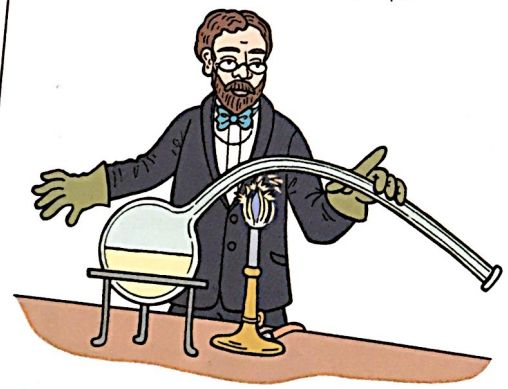
He killed the bacteria he found by gently heating the liquid. He used the same technique with beer and milk. He had invented a process called 'pasteurisation' – it was a huge step forward in keeping liquids free from germs and safe to drink.

3 Pasteur was now convinced that the germs were coming from the air around him. He tried to prove the idea of 'spontaneous generation' wrong.



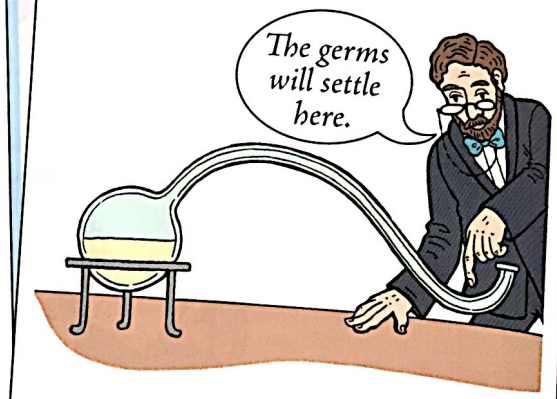
He used two glass containers and put liquid in each. Then he boiled it to kill all the germs.

4 He heated the spout of one flask until it started to melt. Then he bent it into a curvy shape.



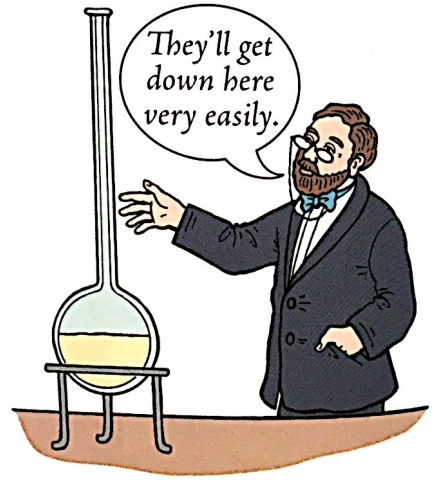
Pasteur claimed that the liquid in the flask with the bent tube would last for years and not turn sour.

5 Pasteur said that the bend in the spout would stop the movement of air.



He said that the germs in the air would settle in the lowest part of the curve and wouldn't reach the liquid.

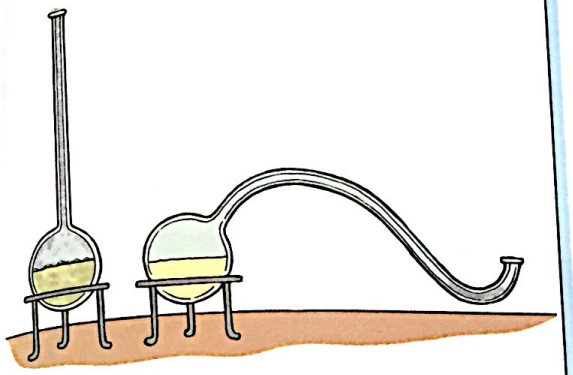
6 Pasteur argued that the liquid in the other flask would soon go bad.



He said that the straight spout would allow germs to get to the liquid easily.

1

Everything Pasteur said was correct.



He had proved that germs did not come alive on their own. Germs will only be found in places they are able to reach. They infect things and turn them bad! The theory of 'spontaneous generation' was dead.

8

In 1861, Pasteur published his '**Germ Theory**'. But he had other ideas.

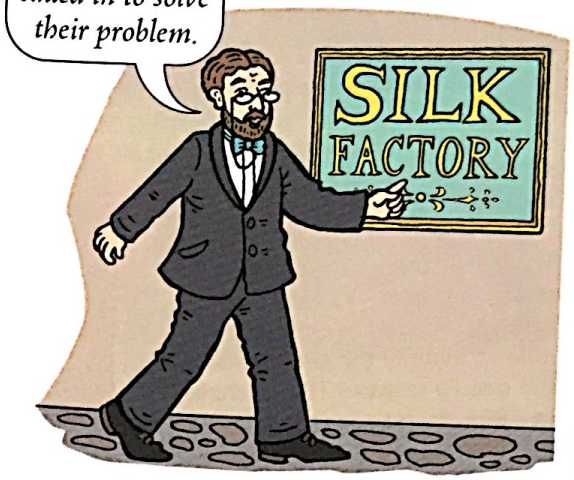
If liquid is damaged by germs, then the same can and must happen in men and animals.

In 1865, he got to test his theory that disease in animals is caused by germs.

9

The French silk industry was being ruined by a disease that was killing their silkworms (the caterpillars that spin silk).

I have been called in to solve their problem.



Through a series of experiments, Pasteur proved that they were dying of a disease called pébrine and it was being spread by a living organism – a germ – in the air!

NB: He didn't publish this 'germ theory of infection' until 1878

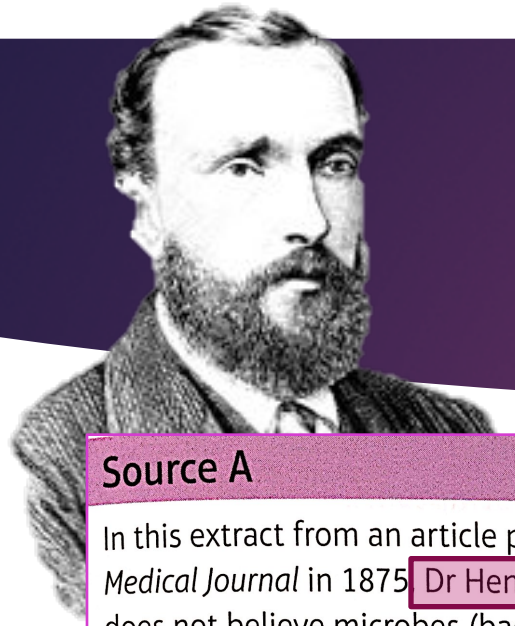
So… Pasteur's problem is - many doctors didn't believe that germs could cause disease in animals because they are too small. He needed Robert Koch to help…

Pasteur had made a momentous breakthrough. He had proven that germs were all around us … and some of them could be harmful and cause disease.

But Pasteur was a chemist and not a doctor. All of his experiments were carried out on liquids such as beer, milk and wine or silkworms. Many doctors didn't even entertain the thought that germs could damage humans too. They thought it ridiculous that something as small as a germ could harm something as large and advanced as a human.

It took a German doctor, Robert Koch, to apply Pasteur's theories to human diseases – and prove that germs caused most of them.

What are Pasteur's problems?



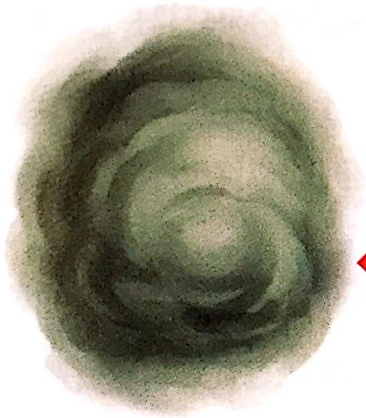
Source A

In this extract from an article published in the *British Medical Journal* in 1875 Dr Henry Bastian explains why he does not believe microbes (bacteria) cause disease.

Bacteria... habitually exist in so many parts of the body in every human being... as to make it almost inconceivable that these organisms can be causes of disease. In support of this statement I have only to say, that even in a healthy person they may be found in myriads... the whole alimentary tract from mouth to anus; they exist throughout the air-passages, and may be found in mucus coming from the nasal cavities... They exist... within the skin, not only in the face, but in other parts of the body. Fresh legions of them are being introduced... with almost every meal that is taken.

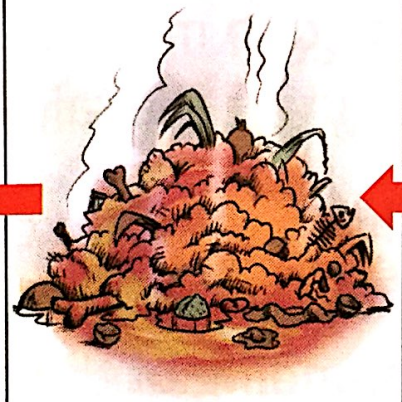
OLD IDEAS

The SPONTANEOUS GENERATION theory claimed rotting matter CREATED microbes.



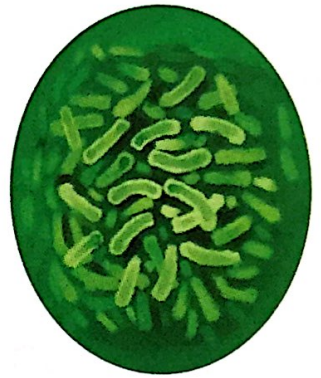
This theory claimed that microbes spread through MIASMATA.

DECAYING MATTER



NEW IDEAS

Pasteur's GERM THEORY claimed that microbes CAUSED DECAY, and were not created by rotting matter.



This theory claimed that microbes spread through the air.

Ok… but does this affect Britain?

- To begin with, no… It had almost no impact on British ideas about the causes of illness and disease. He was not a doctor and only worked on decay on spoilt food, not disease.
- In Britain, the theory of spontaneous generation continued until about the 1870s, being promoted by Dr Henry Bastian (He is the one challenging Pasteur in the video), one of Britain's most important doctors – no one disagreed with him.
- Joseph Lister however did start to look at Pasteur's work… We'll meet him later… His ideas though, were doubted because he couldnt prove his theory. Doctors could not yet identify what the microbes were and what role they played. When they looked in the gut, they saw hundreds of microbes, even in healthy people - it seemed impossible that these could make us sick.
- John Tyndall also liked Pasteurs work, giving lectures on his theory that there was dust particles in the air which carried the germs. People stuck with Bastian and ignored Tyndall.

Video Pasteur Koch: 8:30 – 10.00

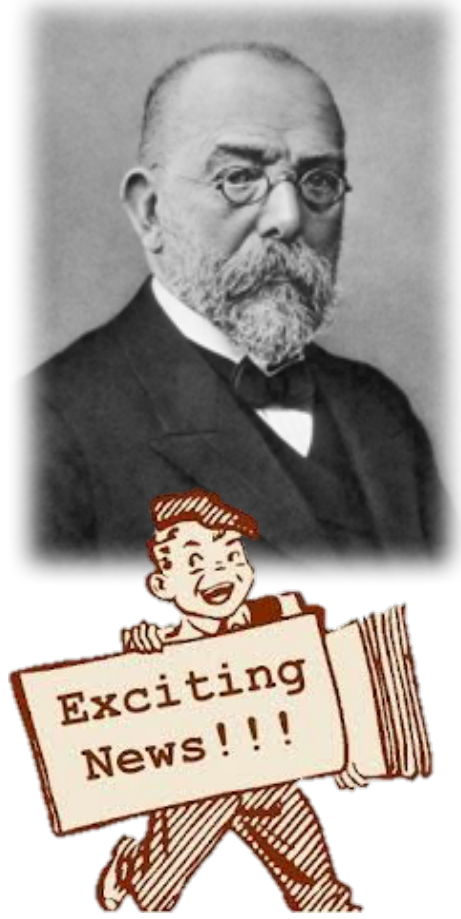
So, who is Robert Koch?

- Pasteur had been the first scientist to identify microbes and their role in decay. It was **ROBERT KOCH** who successfully identified that **different GERMS** cause many common diseases
- Koch discovered the actual bacteria that caused tuberculosis (TB) in 1882
- He then published his methods of identifying disease causing germs (microbes)

Culture = Bacteria grown under controlled conditions

1) The microbe is present in every case of the disease
2) Once taken from the body, the microbe can be reproduced into a pure **culture**
3) The disease can be reproduced in test animals using that culture
4) The microbe can be taken out of the test animals and used to start a fresh culture

Copy this into a flow chart diagram



Koch's work…

The father of bacteriology

- Koch continued to look for the microbes causing different diseases.
- In 1883 he discovered Cholera, in 1884, he proved it was spread in water supplies when he found it in the drinking water in India following a cholera epidemic. This was the final proof for John Snow's theory.
- Koch made it easier for future scientists to study bacteria by developing a new method of growing them, using agar jelly in a petri dish.
- He also developed a method for staining them with dyes to make them easier to see
- Koch's research inspired other scientists who over the next 2 decades went on to discover the microbes responsible for diphtheria, pneumonia, meningitis, the plague, tetanus and many others

His methods are still used today to seek out modern diseases

EXPLAIN WHAT IS HAPPENING IN THIS SOURCE.

YOU'LL NEED TO LOOK VERY CAREFULLY FOR CLUES AS TO WHAT HE'S DOING…

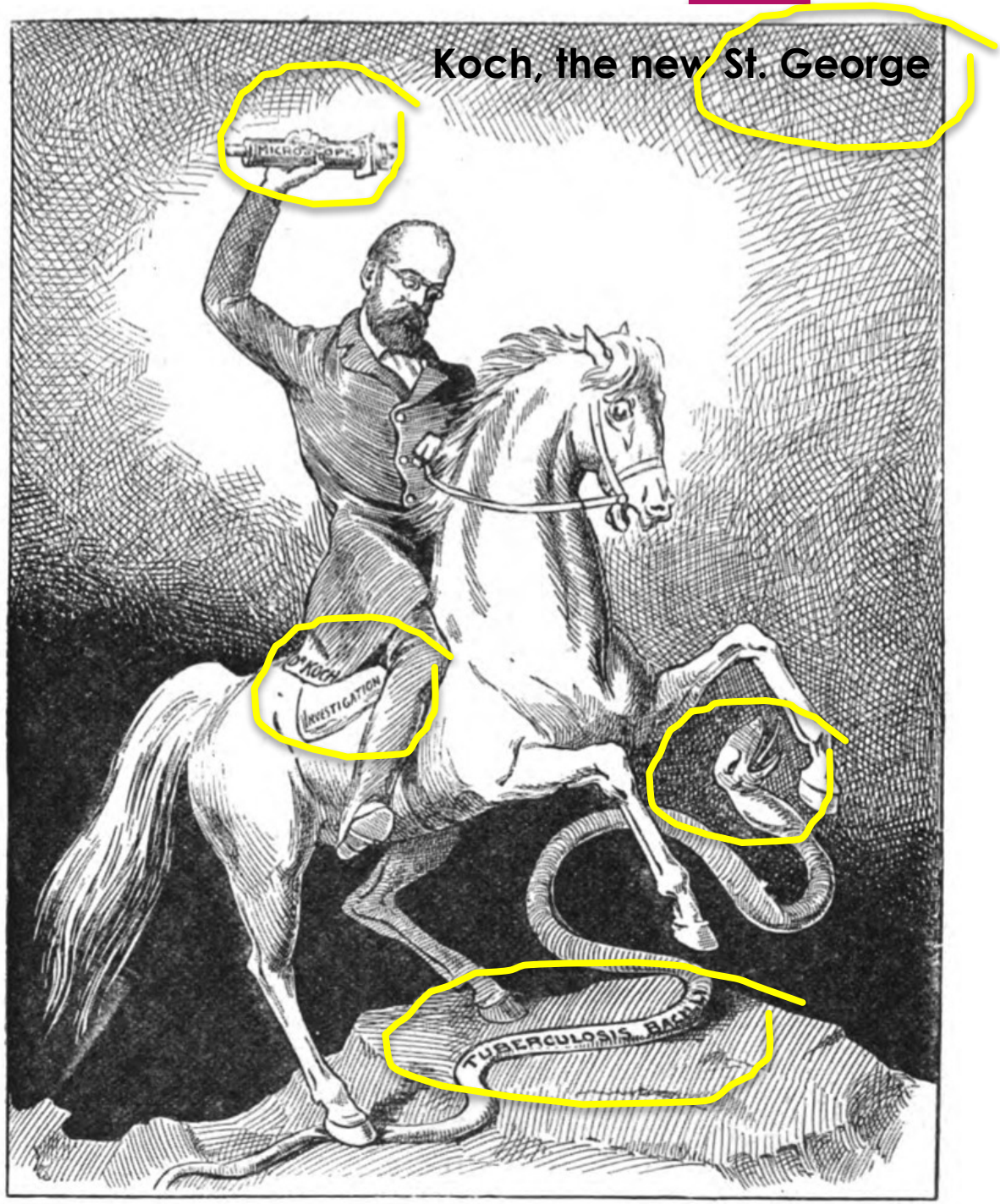
New St. George – Hero, killing an evil monster (British saint who killed the dragon)

Monster is Tuberculosis (mass killer), depicted as an evil snake

Weapon is 'Microscope'

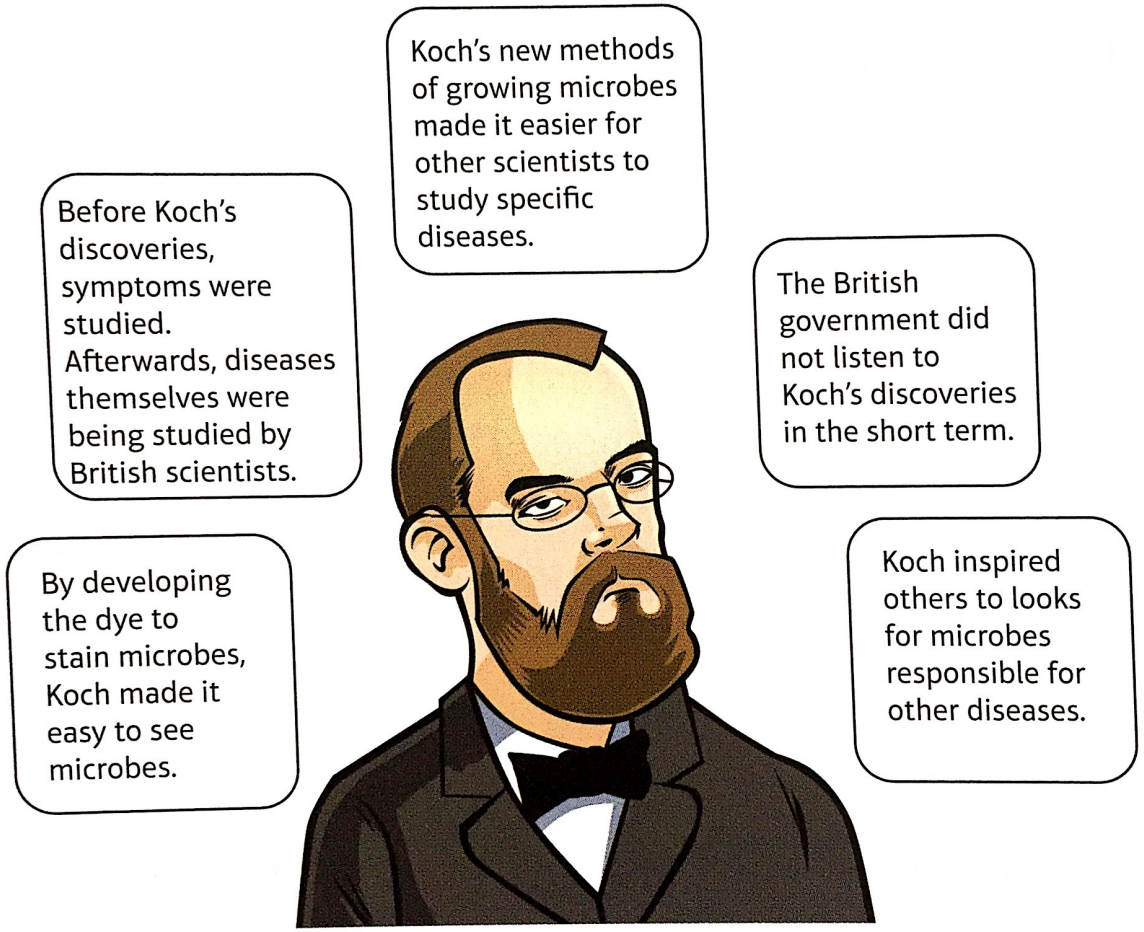
Using 'Investigation skills'

Horse is often seen as warrior like carrying the hero



What was Koch's impact in Britain?

- **Koch's work was an enormous breakthrough in the diagnosis of diseases. He proved to the profession that the microbe created the symptoms of the disease and therefore it was the microbe that needed to be removed.**
- **This knowledge meant scientists and doctors could attack the microbe not the symptom**
- **Pasteur's Germ Theory only really took hold in Britain following the years of work by Koch, Lister and Pasteur himself. The proof of successful vaccinations using these men's ideas was enough.**
- **By the end of the 19th Century, the mystery around what caused illness and disease had been solved! It was now over to the 20th Century to start working on treatments. The study of Bacteriology became a serious industry.**



Fact Check in:

When was the microscope invented?

1677

"…" – Germs appear under the right conditions

Spontaneous Generation

Kills bacteria with heat

Pasteurisation

Germ Theory published

1861

1865

Proves disease in animals is caused by germs

1870-71

Franco-Prussian War

New KEY FACTS & dates:

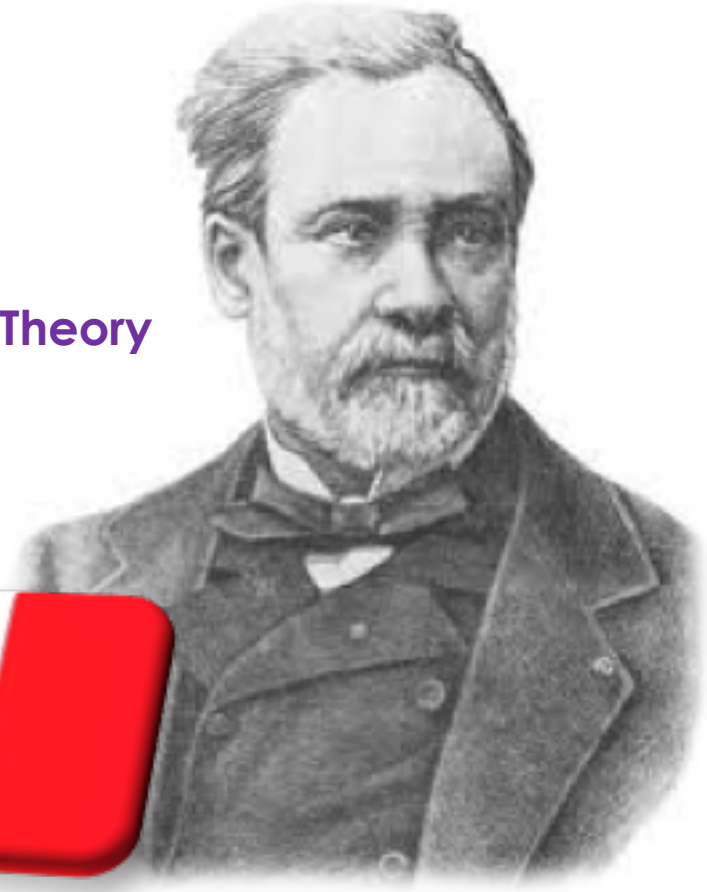
- **KOCH FOUND BACTERIA CAUSING SEPTICAEMIA (BLOOD POISONING) 1878, TB 1882, CHOLERA 1883**

- **CAUSED PASTEUR TO FIND THE VACCINE FOR CHICKEN CHOLERA 1879, RABIES 1885 AND ANTHRAX 1881**

- Create a timeline to show the development of Germ Theory. Include events from the work of both Pasteur and Koch

Debate: Who did more to improve understanding of disease?

Germ Theory



Vs.

Identifying Bacteria

Factors:

Individuals:

The most important individuals were Pasteur and Koch. Other scientists and doctors contributed small parts of the puzzle including John Tyndall and Joseph Lister.

Institutions: Government:

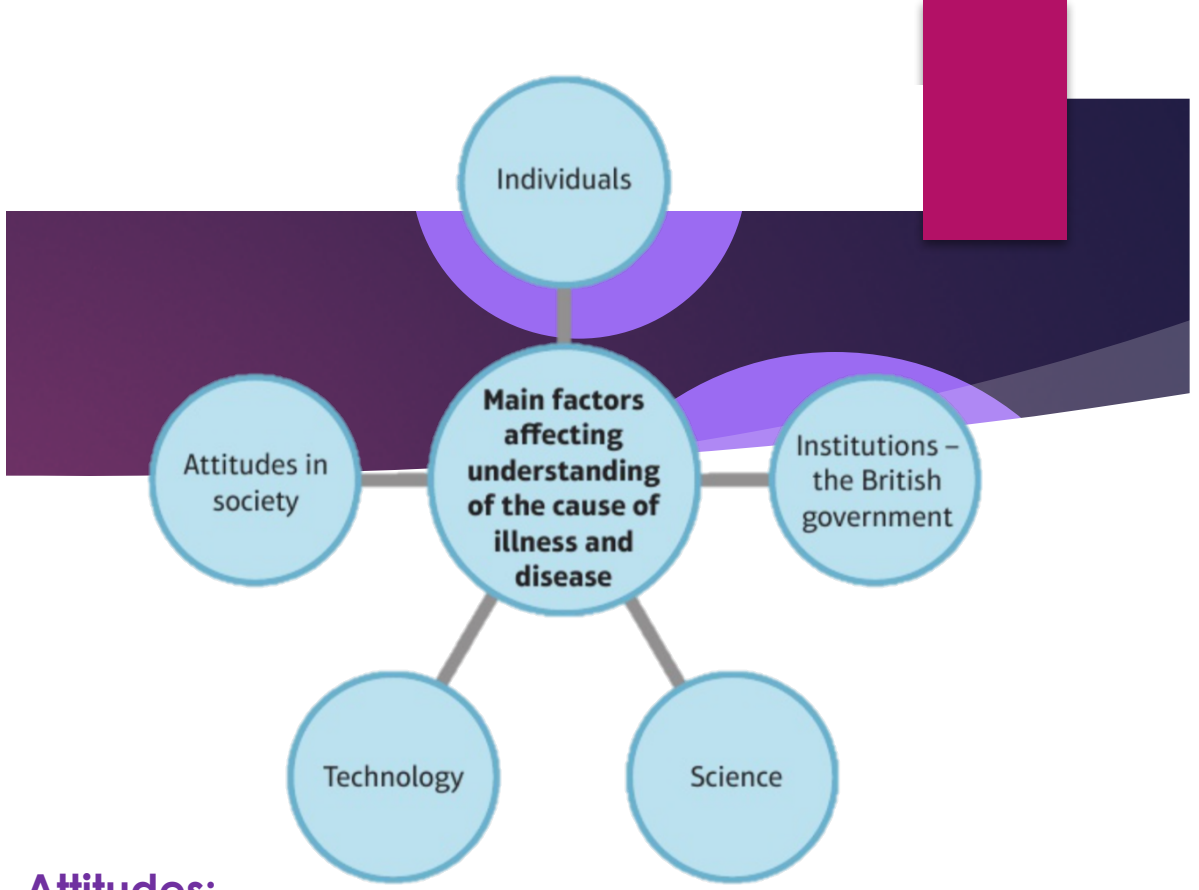
Britain didn't help much, they were not interested in every day life of the people. Once more people could vote, this attitude changed. French & German government contributed greatly in funding their man

Science:

There was a strong desire to prove new theories. Improved communication enabled scientists to share and read each other's work.

Technology:

The microscope was arguable the most important piece of technology that made the development of Germ Theory possible. Koch developed a way to grow microbes and dye them using his agar jelly.



Attitudes:

Attitudes in society were both a help and a hindrance. People were more interested in finding the reasons behind disease and rational explanations for disease.

Overcrowded cities and poor living conditions led to dangerous outbreaks of disease. People were still reluctant to change their minds, many people wa hard evidence which took time.

Checkpoint:

Summary

- In the 18th and 19th centuries, scientists started to theorise about germs being produced by decaying matter, a theory named spontaneous generation.
- In 1861, Louis Pasteur, a French chemist, published Germ Theory. This proved that microbes in the air caused decay in substances such as wine and vinegar.
- Pasteur's work was picked up by some medical professions quite quickly, particularly in Britain where Joseph Lister began attempting to remove microbes from his operating theatre. However, many doctors resisted the ideas.
- Robert Koch, a German scientist, began to look for specific microbes that caused disease. He identified lots of these, including the microbe that caused cholera.
- By c1900, the mystery of what caused many illnesses and diseases had been solved – it was just that not everybody believed the solution yet.

TOPIC TEST NEXT LESSON

Checkpoint

Strengthen

S1 Describe in detail the roles of Pasteur and Koch in developing the Germ Theory of disease.

S2 List the four basic principles of Germ Theory.

S3 Why didn't scientists always believe Koch's ideas about microbes?

S4 How much impact did the Germ Theory have on Britain by c1900?

Challenge

C1 To begin with, Pasteur's work did not have many practical applications. Name some similar discoveries from previous periods.

C2 Which factor do you think had the biggest impact on the development of understanding about the cause of disease and illness? Explain why you think this.

If you are struggling with these questions, ask your teacher for some hints.

Assessment Question: TOPIC TEST NEXT LESSON

Exam-style question, Section B

'There was rapid change in ideas about the causes of illness and disease in the period c1700–c1900.'

How far do you agree with this statement? You may use the following information in your answer:

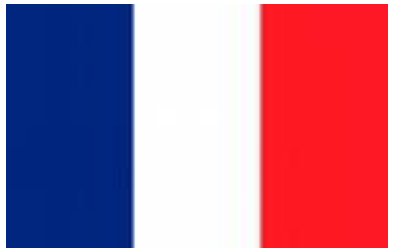
- Spontaneous generation
- Louis Pasteur.

You **must** also use information of your own. **16 marks**

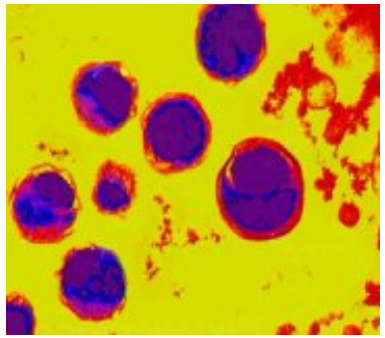
Exam tip

Two hundred years is a long period of time. It is unlikely that rapid change would ever go on for so long. In your answer, try to pinpoint where exactly the rapid change occurred. Make sure you explain what criteria you have used to make your judgement.

France vs. Germany



- Louis Pasteur – French, discovered Germ Theory in 1861
- Robert Koch – German, proved that germs caused illness in humans
- 1870-1871 – war between France and Germany (Franco Prussian War), defeat made the men **hate** each other. They used science to compete with each other.



Part 2:

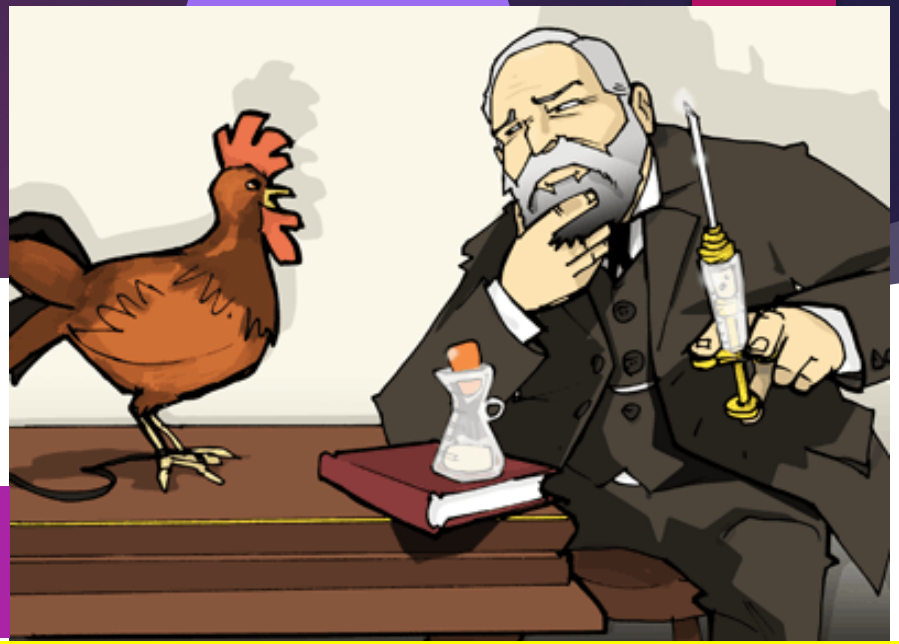
Development and use of Vaccinations:

- By now, it's clear that people believed the best way to avoid dying from a disease was to not catch it at all – **Prevention**
- Following Pasteur and Koch's work, scientists continued to focus on **prevention** and the idea of vaccination

"Following the publication of my Germ Theory in 1861, I published my germ theory of infection in 1878, this says those very microorganisms were actually responsible for disease. I recall the wonderful work of Jenner and wondered if I could take it further and make vaccines for these diseases that keep killing people"

"There's one problem with Jenner's work though, he observed and experimented with his smallpox but didn't focus on the microbe causing it. Other vaccines couldn't work in this way, it is only possible to develop vaccines once the germ causing is has been identified!"

Chicken Cholera

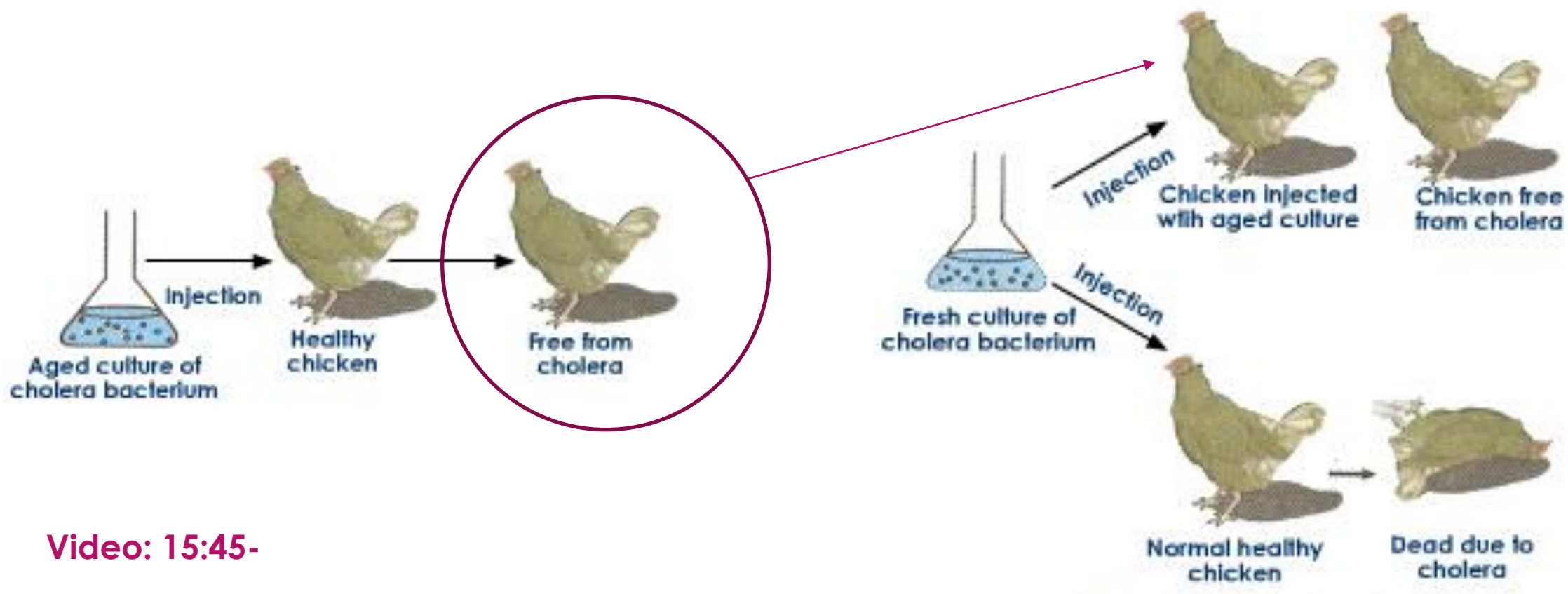


- **What was Chicken Cholera and why was it important?** **Video clip: Pasteur Koch 11:10-14.10**

Create a Story Board with the following headings… P131-132 (White Book will help)

- **Pasteur found the germ causing chicken cholera.**
- **His researcher accidentally injected a chicken with an old, weakened form of the disease after returning from his holiday.**
- **The chickens lived and were protected from the disease. He had accidentally immunised them.**
- **Pasteur found the germ causing anthrax.**
- **They did a public display on sheep to prove a weak form of the disease could immunise animals.**
- **After two years of research, Pasteur developed a rabies vaccine that worked. People flocked to Paris to be treated by him.**

Basically…



Video: 15:45-

So… Vaccines can now be made…

- Pasteur continued making vaccines, using Koch's identifying techniques, and made a vaccine for Chicken Cholera, Anthrax and Rabies.
- Like Jenner, this caused an **immune response** from antibodies left in the body following successfully defeating the weakened form of the disease that was put in the body (antibodies)
- **BUT? you say..** **What question or observation are you going to make?**

- All of this work so far has been on animals!
- **Correct** – But, the important thing to remember is, Pasteur and Koch inspired other scientists who then went on to create vaccines for humans into the 20th Century and beyond! *Eg: Behring developed a vaccine for tetanus and diphtheria in 1890*