

Immunisation

Background, National Curriculum links and suggested aims

This lesson is intended for use when teaching about immunisation to Years 10-11. It has been written for use in a Biology lesson.

Teacher background knowledge

No special background knowledge required for a Biology teacher. However, scientists have found out a lot about the functioning of the immune system over the last twenty years so any science teacher, whatever their specialism, might want to look at some of the resources listed below in 'The biology of the immune system'. Of course, this topic has been much more in the public domain since the advent of the COVID-19 pandemic.

A minor point is that, strictly speaking, 'immunisation' refers to acquiring immunity to (i.e. protection against) any disease where 'inoculation' (the process of introducing a pathogen or relevant antigen into a living organism to stimulate the production of antibodies) is used, whereas 'vaccination' refers specifically to immunisation against smallpox using the cowpox virus (*vacca* being the Latin for cow). In reality, most authors use vaccination and immunisation as synonyms – which is fine – and the term inoculation is less frequently used with students of this age, though the phrase 'inoculated against' is commonly used.

Cross-curricular links

There are links to Philosophy (ethics) and to History.

Student background knowledge

Students need to have a basic knowledge of the immune system, specifically that certain specialised white blood cells, called lymphocytes, react to the presence of certain proteins, called antigens, on invading germs (e.g. bacteria, viruses) by producing their own proteins, called antibodies, which bind to the invading germs and help the body overcome them. (Some specifications may require a distinction to be made between B and T lymphocytes, though this is usually only needed for post-16 courses.) Typically, this antibody production takes a few days or so, which is why it often takes us about a week to get over many of the infections that we catch.

For each of us, once our body has made a particular antibody, it can 'remember' how to do this for many years, sometimes for the rest of our lives. This means that if and when we come across the same antigen again, our bodies can usually counteract it so rapidly that we don't develop the disease (or even realise we have come into contact with it).

Unfortunately, some diseases, like the common cold, have a huge number of possible antigens so, although we are usually less likely as an adult to catch a cold (because we have built up a defence against quite a number of cold viruses), we never build up immunity against all the possible types of cold virus.

Resources and timing

One lesson of 50 minutes could suffice, though there is much to be said for getting students to research the history and/or ethics of immunisation, which would mean that two such lessons would be needed.

Activities

1. The history of immunisation is often presented in school biology books as a triumph of Western medicine, though much better curriculum materials for use in schools do exist. If time allows, students could be introduced to the history of immunisation through consideration of a diversity of primary sources. See the various resources listed below under 'The history of immunisation'. If you want to convey the key historical points more quickly, here are the three key points:
 - a. The practice of 'ingrafting' was used as early as the sixteenth century in China, the Middle East and Africa to prevent smallpox, long before vaccination was used in the West. The procedure typically involved taking a small amount of material from an old smallpox scab or pustule and rubbing it into scratches intentionally made on the person to be treated. The person would usually then develop a less virulent form of smallpox. The practice was brought to the West by a number of individuals, including, in the early eighteenth century, by the redoubtable Lady Mary Wortley Montagu, who had herself contracted smallpox.
 - b. Vaccination was invented by Edward Jenner, who had himself been successfully ingrafted against smallpox as a child. As a teenager he is recorded as hearing a dairymaid say "I shall never have smallpox for I have had cowpox. I shall never have an ugly pockmarked face". In 1796, using cowpox lesions from a young dairymaid, Sarah Nelms, he vaccinated the eight-year-old boy, James Phipps. Two months later he inoculated Phipps with material from a fresh smallpox lesion. No disease developed. As a result, the practice of vaccination spread quite widely – but was fiercely opposed by many.
 - c. The last naturally occurring case of smallpox was in 1977. In the previous 100 years, around 500 million people had died from the disease. In 1980 the World Health Organization (WHO) declared the disease globally eradicated.

2. Even during Edward Jenner's life there was great controversy about vaccination. Nowadays, we would consider the ethics of his original work to be unacceptable but it is questionable whether today's ethical presumptions can validly be extrapolated back in time (doing so is said to be anachronistic). More useful for students is to consider the current debates around immunisation (e.g. against measles). Here are some key points:
 - a. The overwhelming majority of doctors and other health professionals consider immunisations to be of tremendous value. Although, of course, occasionally there are harms – as there can be with any technology – these are considered overwhelmingly to be outweighed by the lives saved and suffering avoided. Presently, the WHO lists 26 diseases for which vaccines are available. Between them, these are estimated to save the lives of about 2.5 million people a year.
 - b. Many people are immunised as young children – when their parents, not they themselves, give consent. In addition, in some countries immunisation against certain diseases is compulsory. Students should discuss whether or not compulsory immunisation is the right or wrong way forward for certain diseases. They should understand and use the terms 'autonomy' (making decisions for oneself), 'public benefit' (good outcomes for society) and 'herd immunity' (resistance to the spread of a disease because a sufficiently high proportion of individuals are not susceptible to the disease, e.g. as a result of immunisation).

Extension activity

- Get students to research the Andrew Wakefield affair.
- Get students to suggest the lessons about successful immunisation that can be learnt from history and from COVID-19.

Resource links

- The biology of the immune system:
<https://www.stanfordchildrens.org/en/topic/default?id=all-about-the-immune-system-90-P01665>, <https://kidshealth.org/en/parents/immune.html>,
<https://en.wikipedia.org/wiki/Lymphocyte>.
- The history of immunisation:
<https://www.ase.org.uk/resources/great-vaccine-debate>,
<https://blogs.bl.uk/thenewsroom/2019/04/vaccination-and-the-media-a-19th-century-debate.html>,
<http://blog.wellcomelibrary.org/2016/05/lady-montagu-and-the-introduction-of-inoculation/>,
<https://en.wikipedia.org/wiki/Variolation>,
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1200696/>.

- The ethics of immunisation:
<https://theconversation.com/the-ethical-questions-raised-by-covid-19-vaccines-5-essential-reads-163604>,
<https://www.palgrave.com/gp/book/9783030020675>,
<https://www.bbc.com/news/health-49507253>,
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1121387/>,
https://www.eurekalert.org/pub_releases/2019-06/b-smv060319.php,
<https://www.vox.com/first-person/2019/5/8/18535944/jessica-biel-measles-2019-outbreak-anti-vax?fbclid=IwAR3dBvc0pFlxG9wRxH6oGhF3Rs67UN0aCnDXWBUDtjOXyUJU4XTObI7pJM0>.
- The Andrew Wakefield affair:
<https://www.theguardian.com/society/2018/jul/18/how-disgraced-anti-vaxxer-andrew-wakefield-was-embraced-by-trumps-america>,
<https://www.healio.com/pediatrics/vaccine-preventable-diseases/news/print/infectious-diseases-in-children/%7B24b5933b-b212-4b86-b170-d8097c205a64%7D/wakefield-study-linking-mmr-vaccine-autism-uncovered-as-complete-fraud>,
https://en.wikipedia.org/wiki/Andrew_Wakefield,
[https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(04\)15710-3/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(04)15710-3/fulltext),
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2831678/>.
- COVID-19:
<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/covid-19-vaccines>,
<https://www.nhs.uk/conditions/coronavirus-covid-19/coronavirus-vaccination/coronavirus-vaccine/>,
<https://post.parliament.uk/covid-19-vaccine-misinformation/>,
<https://www.nuffieldbioethics.org/publications/covid-19/covid-19-ethics-resources>,
<https://link.springer.com/article/10.1007/s11191-020-00143-5>.