Bio Factsheet

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Answering Exam Questions on Immunity and Vaccines

Immunity and vaccination can be confusing. Which of the following statements are true and which are false?

Statement	True	False
Antibodies are cells		
Antibodies clone themselves by mitotic division		
Lymphocytes passing from mother to foetus is an example of natural passive immunity		
Artificial passive immunity is the same as vaccination		
The human body produces its own antibodies via passive immunity		
Antibodies remain in the blood plasma following an infection and confer immunity to a disease		
All antigens are foreign cells		

If you thought that all of these were False, you are a star, and you can cut straight to the questions at the end of this Factsheet. If you thought that any of them were True….Read on!

This Factsheet concentrates on common misunderatandings about vaccines and immunity. These topics are on every exam board and application questions are common.

First, the basic facts:
Vaccines provide protection against bacterial, viral, protozoal and helminthic (worm) diseases
Vaccines are made from:

- Live attenuated (weakened etc.) strains of the organism
- dead organisms
- parts of organisms and
- modified toxins produced by the disease-causing organisms

All of these contain antigens
An antigen is a molecule (often a protein or glycoprotein) which stimulates an immune response / antibody production.
Vaccines can be injection into the skin, muscle or bloodstream. Oral vaccines can be swallowed and can pass through the stomach and be absorbed through the gut wall without damage.

Note: Vaccines containing attenuated microorganisms are usually preferable to those containing dead microorganisms because:

- They more closely resemble a real infection;
- They provoke a better immune response since the dead organisms may have modified antigens;
- Less inoculum is required/immunity may be longer lasting;

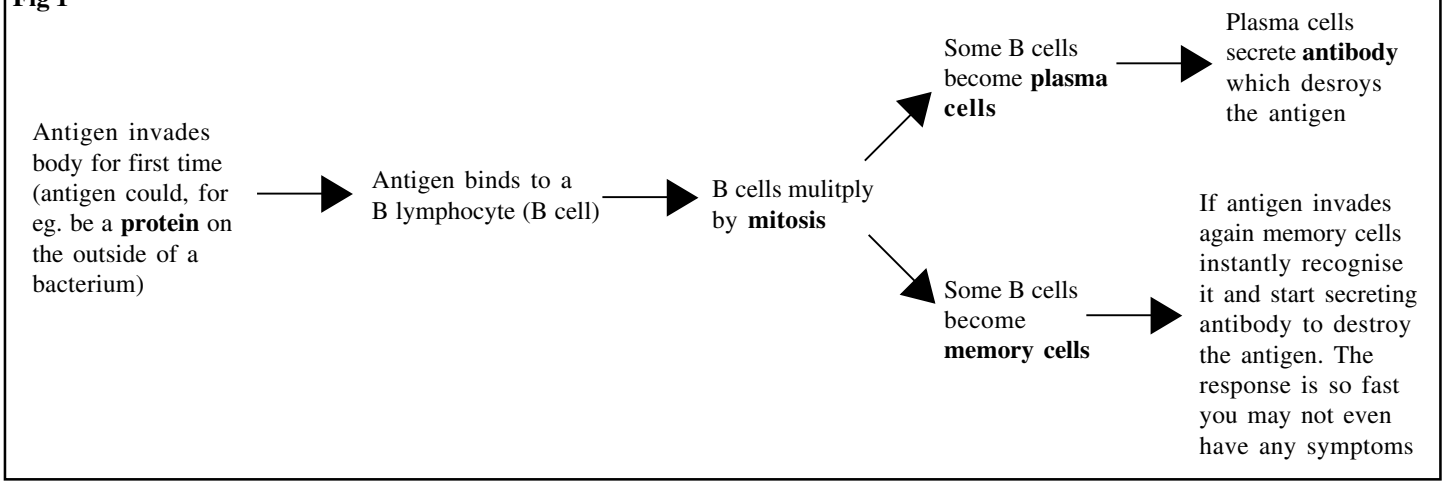
Table 1. There are 4 types of immunity:

Type	How acquired?	Short –term or Long –term?	Involves immune response?	Involves memory cells?
natural active	illness/disease/infection/antigen enters body	Long –term	Yes	Yes
artificial active	Vaccination or antigens injected	Long -term	Yes	Yes
natural passive	antibodies in colostrums / (breast) milk/cross placenta	Short-term	No	No
artificial passive	injection of anti-serum/anti-venom/ tetanus antibodies / antibodies made in an animal / another human	Short - term	No	No

Exam Hint: *Make sure you understand why artificial passive is* ***not the same*** *as vaccination*

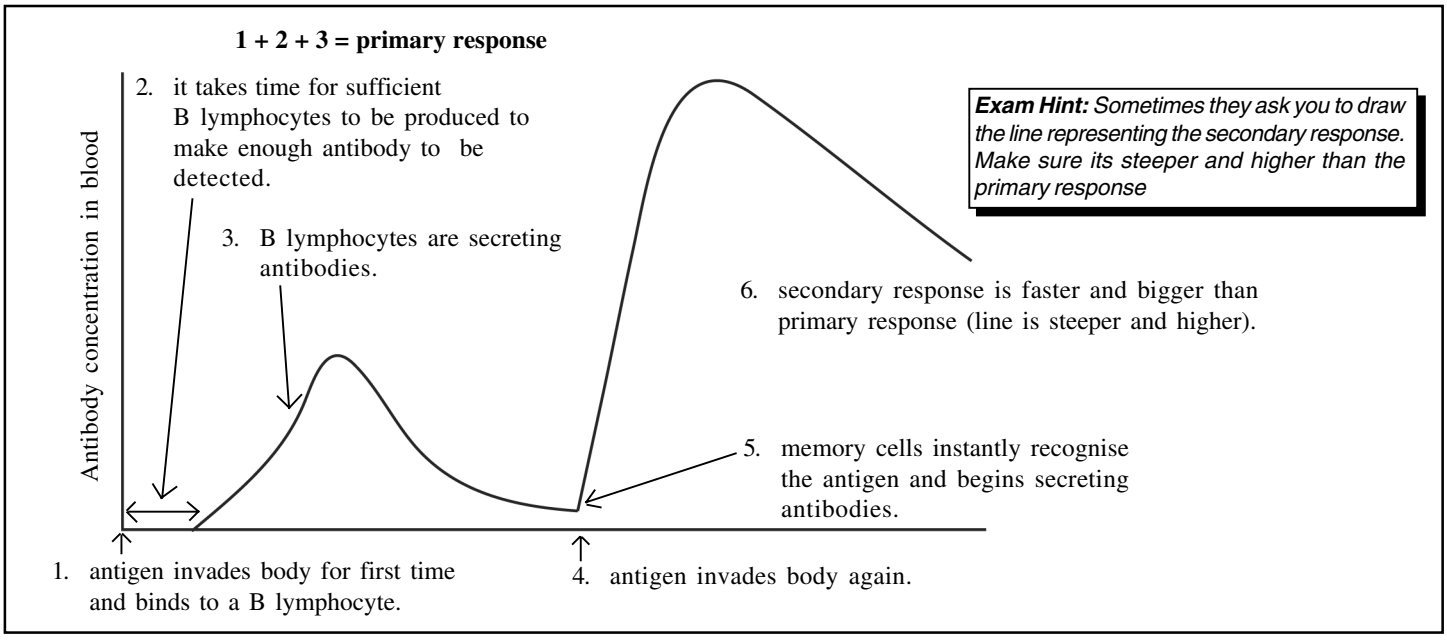
The flow chart shows what happens when an antigen enters our body (Fig 1)

Fig 1



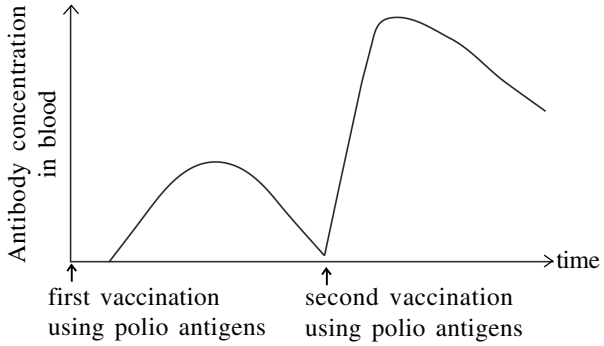
Vaccinations aim to stimulate your immune system to mount a primary response. The memory cells that remain then provide a vigorous secondary response if and when the real pathogen enters your body.

Fig 2. Typical exam question- describe/explain the graph



Typical exam Question

Marie was given two vaccinations using antigens from the virus that causes poliomyelitis. The graph shows the resulting concentration of antibodies in Marie's blood.



Question. Explain the difference in Marie's response to the two vaccinations.

Answer

After first vaccination it takes time for B cells to become activated / there is a time delay before antibodies can be produced;
Memory cells present as a result of first vaccination;
Second vaccination results more rapid and greater production of antibodies;

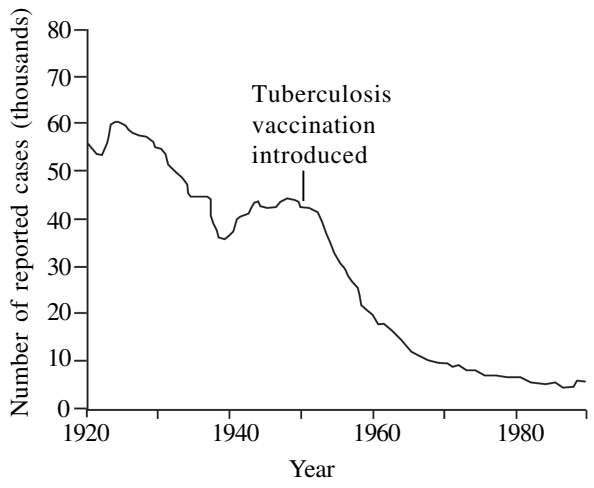
Extracts from Chief Examiners' report

"Both vaccines and antibodies were confused with antibiotics. Many candidates believe that antibodies are cells, and frequent references to antibodies multiplying, cloning by mitosis or reproducing were seen……..Many candidates believe that antibodies, not memory cells, remain in the blood plasma following an infection and confer immunity to a disease"

The aim of vaccination campaigns is to ensure that a very high percentage of the population receives the vaccine. If, for example, you can vaccinate 95% of the population, only a few (5%) are susceptible to infection, and the chances of contact between these few people would be low. Widespread vaccination protects the whole population since it results in a smaller reservoir of the pathogenic organism in the population. This is the so-called **herd effect**

Fig 3 shows the number of reported cases of tuberculosis in the UK between 1920 to 1990.

Fig 3. Reported tuberculosis cases 1920 to 1990

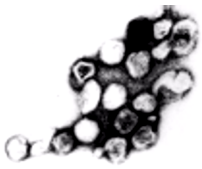


Typical Exam Question

Question: Is it true to say that the vaccination programme was solely responsible for the decline in tuberculosis?

Answer:
No;
Numbers were falling before vaccination was introduced;
Because of better housing conditions / improving diet/ better awareness of disease / improved medical care;
Fewer susceptible people / more immune;
Availability of antibiotics post circa 1940;

Case Study: Rubella



Rubella is caused by a virus

It occurs worldwide and is normally a mild childhood disease

The real problem is that infection during early pregnancy may cause foetal death or multiple defects, particularly to the brain, heart, eyes and ears

Humans are the only host. Rubella virus is transmitted by the respiratory route and the virus replicates in the nasal mucus

The rubella vaccine is a live attenuated strain of the virus propagated in human diploid cells. It is stored at 2–8°C and protected from light

The single vaccine is injected under the skin. Sometimes it is used alone, but it can be combined with a measles vaccine or mumps vaccine, or in a triple form: the measles-mumps-rubella vaccine (MMR)

In clinical trials 95%–100% of susceptible persons aged 12 months and older developed rubella antibodies by 21–28 days after vaccination. Protection is then lifelong.

Typical Exam Questions
1. Suggest why girls are vaccinated against *Rubella* when they are young.
2. Suggest why young boys are also vaccinated against *Rubella*

Answer
1. To provide immunity before the time when they might become pregnant.
2. To reduce the potential number of sources of the virus and the likelihood of infecting unprotected females.

An understanding of the basic principles of the immune response helps us to tackle application questions: those that test our ability to apply knowledge to topics that aren't even on the specification.

Typical Exam Question
Suggest why a person may have influenza several times, but usually has measles only once

The first time a person gets measles or influenza, the primary response is evoked;
The resulting memory cells do their job in measles so the question is: Why, when the second 'flu attack comes, don't the memory cells unleash millions of antibodies, thus stopping the second 'flu ?

The answer is that whereas the measles virus carries just one antigen or an antigen that doesn't change, the flu virus exists in many different strains, each carrying different antigens. Additionally, the flu virus has several antigens and antigens that keep changing. Thus the original memory cells cannot recognize the antigens and are ineffective. Thus the immune system, in dealing with these new antigens, effectively has to start again.

Practice Questions
1. Attempts have been made to encourage the wider use of oral vaccines. One idea is to genetically alter banana plants so that the vaccine is synthesized in the banana.
   (i) Suggest two advantages and
   (ii) two disadvantages of such vaccines. (4)

Answers
1. (i) advantages
medical staff not needed;
bananas grow in places where vaccines are needed;
no injection necessary;
cheaper to produce;
no need to refrigerate;
(ii)disadvantages
antigen is protein so may be digested when eaten;
less effective than traditional vaccines / difficult to control dose;

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