4-43

Type of vaccine	Description
Live attenuated vaccine	Vaccine contains live weakened bacteria. The bacteria can reproduce but cannot cause disease
Inactivated or killed vaccines	Vaccine contains inactivated viruses or killed bacteria
Inactivated bacterial toxin	The vaccine contains a toxin that is modified to be harmless
Pathogen sub-unit	The vaccine contains antigens made from one or more sub-units of the pathogen

4-44 The first injection results in the recognition of the antigen and the production of B plasma cells, which produce antibodies and B memory cells. Gradually the antibodies are destroyed but the memory cells remain. After the booster injection, these memory cells quickly divide and produce many antibodies and more memory cells.

4-45 The reason is as described in the previous question but to develop a sufficient number of memory B cells four doses of the vaccine are required. For future protection further booster shots are needed to prevent infection.

4-46 Quarantine is used to stop the spread of disease in the first instance. Isolating possibly infected and infected individuals means that the pathogen cannot come in contact with healthy individuals. Quarantine does not protect a population from future infections. Vaccines do but vaccination takes time to develop, administer and then for immunity to develop. Vaccines induce an immune response, and this provides long-term immunity against the pathogen. The greater the number of individuals vaccinated, the lower the chance of the pathogen finding a host and therefore the spread of the disease is contained.

4-47 Herd immunity is the immunity provided when most of the population has been immunised. This reduces the number of individuals the pathogen can infect therefore reducing the chance that the pathogen can find a host, survive and spread to individuals not vaccinated.

4-48 Multiple sclerosis is an autoimmune disease where the body produces antibodies that attach the myelin sheath surrounding its own nerve fibres. The destruction of myelin results in slowed or blocked nerve impulses.

4-49 Cancer results from uncontrolled growth of a single cell. The uncontrolled growth occurs due to damage to genes that control the cell leading to a resistance to apoptosis.

4-50 Tumour cells evade the immune response by:
- proteins as their MHC class 1 bind to natural killer cells and cytotoxic cells preventing the cytotoxic T cells and killer cells from destroying the tumour cells.
- producing cytokines that suppress cytotoxic T cells and Natural killer cells.
- releasing enzymes that suppress cytotoxic T cells and Natural Killer cells.

4-51 Immunotherapy is a disease treatment that works by either activating or suppressing the immune system.

4-52 Monoclonal antibodies are artificially mass-produced identical antibodies. They are produced by injecting an antigen into an organism such as a mouse. The mouse's immune system responds by activating B plasma cells to produce specific antibodies against the antigen. These specific antibodies are then isolated and injected into the patient. Monoclonal antibodies can be produced that target antigens present on cancer cells. The antibodies bind with the cancer cells marking them for destruction.

4-53 Ocrelizumab is a monoclonal antibody that is used to treat multiple sclerosis. This monoclonal antibody targets receptors on B-cells reducing their ability to attack the central nervous system. Other drugs include anti-inflammatory monoclonal antibodies that inhibit cytokines that are involved in abnormal inflammatory response like rheumatoid arthritis.

4-54 Monoclonal antibodies are produced that have a complementary shape to match the surface of tumour cells. Drugs or radioactive substances are incorporated into the antibody structure. The antibodies are given to the patient and deliver the drug or radioactive substance only to those cells carrying molecules with a shape complementary to the antibody.

4-55

Type of cancer vaccine	Antigens contained in the vaccine	How the vaccine works
Preventive	Viral antigens	Provides immunity against viruses that cause cancer e.g. HPV vaccine
Therapeutic	Antigens found on specific cancer cells	Given to people who already have cancer to booster the immune response.
Personalised	Antigens from the patient's own tumour cells	Cells are removed from the tumour; antigens are removed to make them more obvious and then injected back into the patient.

Chapter 4: Multiple-choice questions

4-56 [VCAA 2015 SA Q17]
Which one of the following is an example of a plant defence against a pathogen?
D waxy leaf surfaces acting as physical barriers. (Plants do not have the sophisticated immune systems of animals. Most defence relies on physical barriers such as a layer of wax.)

4-57 [VCAA 2014 SA Q15]
The first line of defence against pathogens includes the
B presence of acid in the stomach. (The first line of defence refers to barriers stopping pathogens entering body tissue. The stomach is an extension of the external environment. A low pH will destroy pathogens before they are able to cross the gut wall. The release of histamine and interferon are part of the second line of defence and helper T cells the third line.)

4-58 [VCAA 2013 SA Q14]
As part of the first line of defence in the human immune system, naturally occurring barriers to invading pathogens include
A lysozymes in tears. (The first line of defence refers to the external barriers to infection. Inflammation and phagocytes are involved in the second line of defence and antibodies in the third line of defence.)

4-59 [VCAA 2019 SA Q20]

What is happening at position 3?

A Enzymes that break down the microorganism are released into the vesicle. (At position 3 a vesicle containing enzyme comes into contact with the vesicle containing the pathogen. This is a diagram of phagocytosis. There is no evidence of antigen presentation.

4-60 [VCAA 2016 SA Q20]

The inflammatory response is a defence mechanism that evolved in higher organisms to protect them from infection and injury.

This response

A includes phagocyte migration to the site of the injury. (Phagocyte migration is part of the inflammatory response, which is the initial general non-specific response to potential infection.)

4-61 [VCAA 2015 SA Q18]

In the region around the small piece of wood embedded in her finger

C the capillaries would become more permeable. (The increased permeability is part of the immune response allowing macrophages easier access to the tissue. Note red blood cells do not normally leave blood vessels and mast cells release histamines.)

4-62 [VCAA 2014 SA Q16]

An example of a non-specific response by the immune system is

A phagocytes engulfing non-self-material. (T and B cells are involved in the specific immune response.)

4-63 [VCAA 2013 SA Q15]

Defence mechanisms against bacterial pathogens include

C destruction by complement proteins. (Interferon and cytotoxic T cells defend the body against viral infection and histamines are involved in allergic reactions.)

4-64 [VCAA 2012 E1 SA Q10]

Cells moving from the blood vessel towards the bacteria

B would act as phagocytes. (Histamines cause vasodilation and are released by mast cells.)

4-65 [VCAA 2012 E1 SA Q23]

Interferon is a chemical that

B protects uninfected cells from viral attack. (Fact)

4-66 [VCAA 2011 E1 SA Q6]

It is reasonable to infer that an infection has occurred if

D pathogens are found in leg muscle tissue. (The term pathogen describes a disease-causing organism. Histamines are released for a variety of reasons including responses allergenic materials. Scabs may occur in association with an infected cut but not necessarily. There are always bacteria in the gut and most are beneficial.)

4-67 [VCAA 2011 E1 SA Q8]

Nonspecific defences of the immune system that act against bacteria include

B phagocytes. (The other alternatives all refer to items that are part of the specific responses. Phagocytes are large white blood cells that have a general role in removing potentials threats such as bacteria.)

4-68 [VCAA 2015 SA Q15]

Which one of the following is true of prions?

B They cause some brain diseases. (Prions are smaller and simpler than viruses, are made of proteins and do cause some brain diseases. Therefore, they are not cellular, lack cell walls and lack nucleic acids.)

4-69 [VCAA 2014 SA Q14]

An example of 'self' material in an adult human female is

C cells lining her nose and trachea. (All other alternatives do not include cells that are found in an adult human female.)

4-70 [VCAA 2012 E1 SA Q9]

Major Histocompatibility Complex (MHC) class 1 molecules

C present foreign antigens to B and T cells. (MHC 1 markers are found on all cells except red blood cells. Plasma B cells produce antibodies.)

4-71 [VCAA 2017 SA Q23]

The lymphatic system includes the lymph nodes, spleen and tonsils.

In these particular organs

B clonal selection and proliferation of B cells occurs.

(Clotting factors are activated to help seal a wound. Non-self-antigens are not identified by red blood cells and the initial response to an allergen is triggered by mast cells lining blood vessels.)

4-72 [VCAA 2013 SA Q18]

This disease would result in the

C reduced production of T cells. (T cells mature in the thymus gland therefore disrupting the normal development of the thymus gland will reduce the production of mature T cells. Lymph nodes, B cells and mast cells are not directly associated with the thymus gland.)

4-73 [VCAA 2013 SA Q20]

In the lymphatic system

A clonal selection occurs. (Lymph is not pumped by the heart, arteries not lymph vessels have thick muscular walls and mast cells are not involved in clonal selection.)

4-74 [VCAA 2011 E1 SA Q7]

The lymphatic system contains

C B cells and T cells. (Fact!)

4-75 [VCA 2018 SA Q17]

Which of the following lymphocytes are activated by antigen-presenting cells?

A T helper cells (Definition: This is a definition of the job of a T helper cell.)

4-76 [VCAA 2019 SA Q19]

In adaptive immunity, which cells, directly destroy virally infected cells?

D T cytotoxic cells. (Fact. T helper cells activate the immune system and B cells divide into plasma cells that produce antibodies.)

4-77 [VCAA 2013 SA Q19]

Cytotoxic T cells are

B able to kill virus-infected cells. (Cytotoxic T cells are involved in the cell-mediated immune response and antibodies are involved in the humoral response.)

4-78 [VCAA 2017 SA Q22]

Which of the following matches a cell correctly with its role in an immune response?

	Cell	Role
B	**dendritic cell**	**presents fragments of antigens to T helper cells**

(Macrophages and neutrophils engulf bacterial and mast cells are involved in inflammation.)

4-79 [VCAA 2019 SA Q23]

Based on your knowledge and the information in the graph above, what is the effect of the change in the number of T cells over time?

B loss of effective function of the adaptive immune system. (The role of T cells is to activate the immune system. As the T cell count drops in the body, the immune system becomes less effective in combatting the virus.)

4-80 [VCAA 2015 SA Q16]

Consider the following diagram of four pathogens and three antibodies.

Which one of the following statements is correct?

B Antibody F is effective against three of the pathogens. (You need to identify matching binding sites. The binding site an F corresponds to at least some sites on Pathogen S, T and F.)

4-81 [VCAA 2012 E1 SA Q16]

Agglutination of blood cells would occur if

D antibodies of type B were added to a sample of group AB blood.

(Blood group AB has both A and B antigens therefore if type B antibodies were added they would combine with the B antigens forming agglutination or clotting. Blood group O has neither antigen therefore adding either A or B antibodies will not result in agglutination. Blood group A does not have B antigens therefore no agglutination will occur.)

4-82 [VCAA 2011 E1 SA Q13]

An appropriate antibody to use against these antigens would be type

B.

(The antigen binding sites of alternatives B & C match the antibody shape. Alternative **B**, however, is correct because it shows appropriately the heavy chain on the inside of the molecule.)

4-83 [VCAA 2020 SA Q19]

The role of T helper cells is to

B control the adaptive immune response. (The clue is in the name – helper cells. T helper cells signal other cells to gather and respond to an infection. This may result in the production of antibodies by B cells and the attraction of phagocytes.)

4-84 [VCAA 2020 SA Q20]

Which one of the following describes a feature common to both T cells and B cells?

A having immunological memory (The body has populations of B cells and T cells that react to specific threats. After an initial infection or vaccination, greater numbers of memory T and memory B cells specific to a particular antigen will circulate in the body, providing a more rapid response to subsequent exposure.)

4-85 [VCAA 2020 SA Q21]

The property of the immune system that enables it to fight infections and destroy cancer cells is the

C ability to distinguish self from non-self-biological molecules. (This is a critical feature of the immune system – recognising the body's own useful cells and not attacking them. The breakdown in the immune system in the case of autoimmune diseases results in the immune system attacking useful, healthy cells.)

4-86 [VCAA 2019 SA Q21]

In adaptive immunity, which part of this process allows long-term (sometimes lifetime) protection against pathogens?

C generation of memory cells. (Long-term memory is produced when the body's defence system comes-into-contact with a particular pathogen. B cells will respond by producing antibodies and more clones of themselves that act as memory cells to protect against future attack by the same pathogen.)

4-87 [VCAA 2009 E1 SA Q20]

The microorganism most likely to cause a severe infection is

B N. (There are no antibodies present that fit the antigens on the N bacteria.)

4-88 [VCAA 2018 SA Q23]

Following the injection, this person should have

D artificial passive immunity. (The person has immunity because they have received antibodies. The immunity is passive rather than active because the person has received antibody rather than making their own.)

4-89 [VCAA 2016 SA Q23]

This is because antivenom serum is used to achieve

D passive and induced (artificial) immunity. (The immunity will not last as the body's immune was not stimulated. The introduced antibodies will gradually disappear.)

4-90 [VCAA 2011 E1 SA Q9]

Antibodies passed from a mother to her baby during breast-feeding would be best described as

A naturally acquired, passive immunity. (The baby acquires antibodies naturally from the mother and because the baby is not producing the antibodies the immunity is passive.)

4-91 [VCAA 2011 E1 SA Q24]

From the information in the table it is reasonable to infer that

C Emily has been infected with the greatest number of different viruses. (Emily has produced three of the antibodies under study and therefore has been exposed to three of the viruses studied. A particular antibody will be produced when an individual is exposed to the specific virus that causes that antibody production.)

4-92 [VCAA 2011 E1 SA Q25]

From the information given in the table it is reasonable to infer that Becky would be given

B vaccines for influenza B and RSV. (Becky has not produced antibodies to influenza B or RSV so would do well to receive vaccines for these two viruses.)

4-93 [VCAA 2009 E1 SA Q21]

It is reasonable to conclude that

C lymph nodes are involved in the acquired immunity phase. (Macrophages are involved after the pathogen passes the organism's physical barriers, innate immunity involves living cells and protection developed against the disease continues after the initial infection.)

4-94 [VCAA 2012 E1 SA Q24]

This test for HIV is reliable because the

D HIV antigen has a complementary shape specific to the HIV antibody. (This allows the HIV antigen to attach to the HIV antibody. If the antibody and the antigen had the same shape, they would not bind together.)

4-95 [VCAA 2012 E1 SA Q25]

Values below 0.300 are considered to be negative. The results of these tests suggest that

C patient S has responded to exposure to HIV by developing antibodies. (Antibodies are produced after exposure to the virus therefore patient T has been exposed. The positive control contains more antibodies than the negative control. Patient R has a reading of less than 0.300, therefore has not been exposed to the HIV antigen.)

4-96 [VCAA 2013 SA Q16]

Using the information given, it can be concluded that

A the viral vector is a mosquito. (The virus is a non-cellular pathogen. The mosquito transfers the viral particles from kangaroos and wallabies to humans therefore, the mosquito is a vector.)

4-97 [VCAA 2013 SA Q17]

The most effective way to reduce the incidence of Ross River fever in Australia would be to

B use an attenuated form of the virus to create a human vaccine. (It would be very difficult to stop humans living near the Ross River or to isolate the kangaroos and wallabies. Treating the symptoms will not reduce the chance of infection. Immunising will stop viral particle production and therefore decrease the chance of infection.)

4-98 [VCAA 2016 SA Q21]

It is reasonable to say that *S. anatum*

D a bacterium. (*S. anatum* is a bacterium and bacteria are killed by antibiotics. Bacteria can reproduce on the surface of the body and in tissue fluid.)

4-99 [VCAA 2016 SA Q22]

It can be concluded from the data that

A there are four periods in which the notification rate is greater than six per 100 000.

(There are four peaks above six per 100 000: Feb 00, Mar 02, June 03 and Jan 04. Careful reading of the graph shows the alternatives to be incorrect.)

4-100

Why are quarantine measures needed when there is an outbreak of an infectious disease in Australian farm animals?

D To prevent the disease from spreading to farm animals in different regions of Australia. (Quarantine refers to the process where animals from another area (often another country) are kept separate until authorities are sure that they are free of contagious infectious diseases.)

4-101 [VCAA 2018 SA Q29]

Based on the information in the graph, what is the most likely reason for the change in death rates, even though infection rates continued to climb after 1995?

A People had access to new antiviral drugs. (Education has occurred but is not the major cause of reduced death rates and vaccination is still a research area. The major cause is the use of antiviral drugs that reduce the levels of HIV in a person to negligible levels allowing them to survive.)

4-102 [VCAA 2018 SA Q32]

What would be the most effective method of preventing the spread of measles during an outbreak?

D Isolate all infected people. (As measles is spread by airborne droplets the only effective way of preventing spread is by isolating infected people. Vaccination is useful in preventing outbreaks but does not assist people who are already infected.)

4-103 [VCAA 2018 SA Q33]

Based on the information in the table, which one of the following statements is correct?

B Polio and smallpox have a similar infection rate. (From the information given, polio and smallpox have a similar infection rate. Other alternatives may be correct, but information is not available.)

4-104 [VCAA 2017 SA Q37]

Which one of the following is a correct statement about this outbreak of yellow fever?

D Elimination of mosquito breeding sites in areas with yellow fever will reduce the number of individuals affected.

(The outbreak is confined to Brazil, so it is not global and therefore not a pandemic. No information is given about vaccination rates and travel will increase not decrease the spread of disease.)

4-105 [VCAA 2020 SA Q34]

Which combination of approaches would be most effective at controlling the risk of outbreaks of both vCJD and yellow fever?

	vCJD	Yellow Fever
C	Destroy all cattle that have been fed infected food containing the prions.	Ensure that people take measures to reduce their chances of being bitten by mosquitoes.

(As vCJD is caused by ingesting meat containing prions alternatives B, C, and D would control outbreaks. Yellow fever develops as a result of a mosquito bite, only A and C reduce the chance of being bitten.)

4-106 [VCAA 2017 SA Q26]

Which one of the following conclusions can be made using this data?

A Memory B cells were activated by exposure to the same strain of the influenza virus on day 22. (B plasma cells were most numerous day 34–36, vaccination occurred at Day 0 and no information is provided about the rest of the population so no conclusion about herd immunity can be reached.)

4-107 [VCAA 2016 SA Q24]

CSP is secreted by the malaria parasite and is present on its surface.

For the vaccination to work, the scientists want CSP to act as

A an antigen. (Antigens provoke the immune system to produces its own specific antibody producing cells – in this case specific to producing protection from malaria.)

4-108 [VCAA 2015 SA Q14]

Which one of the following events could have occurred on day 30?

C an injection of antibodies to VZV into the person. (At 30 days, there is an immediate increase of antibodies. The immune response would take time, so A and B are incorrect. A dose of antibiotics will not affect antibody concentration.)

4-109 [VCAA 2012 E1 SA Q18]

Using your knowledge and the information given, it would be correct to conclude that

D baby 4 was exposed to the rubella virus during foetal development. (IgM antibodies do not cross the placenta therefore if they are present in the baby, the baby must have produced them. This means that the baby must have been exposed to the virus in the uterus.)

4-110 [VCAA 2012 E1 SA Q19]
The immunity the baby acquires as a result of this vaccination is called
B active and induced (artificial). (Active because the baby produces the antibodies and induced because the vaccine not the virus stimulates the immune system to produce the antibodies.)

4-111 [VCAA 2020 SA Q35]
Monoclonal antibodies
B make it easier for cells of the immune system to detect cancer cells. (Monoclonal antibodies bind to markers of the surface of cancer cells tagging these cells for identification by phagocytes and cytotoxic T cells.)

4-112 [VCAA 2020 SA Q25]
DOCK8 syndrome could be classified as
D an immune deficiency disease. (If the B and T cells are defective, the body will not be able to defend itself against invading bacteria or viruses. Also, these cells are important in stimulating the removal of damaged cells that might lead to cancer.)

4-113 [VCAA 2019 SA Q22]
In multiple sclerosis, which specific part of the nervous system do immune cells attack?
B the myelin sheath around nerve cells. (Fact: In MS, nerve transmission is slowed due to the damage to the myelin sheath.)

4-114 [VCAA 2018 SA Q16]
Lupus is an example of
B an autoimmune disease. (The body is producing antibodies that are attacking its own healthy cells – therefore an immune response.)

4-115 [VCAA 2016 SA Q25]
Considering the information above, temporal arteritis is
D an autoimmune disease. (Elastin is a normal protein to which the body's immune system should not respond. Such responses are called autoimmune responses.)

4-116 [VCAA 2015 SA Q19]
Autoimmune diseases are different from diseases caused by pathogens because in all autoimmune diseases
A certain self-tissues are not recognised as 'self' and this causes an immune response to the tissues. (In autoimmune diseases, the body's immune system is producing antibodies that damage the body's own tissues.)

4-117 [VCAA 2017 SA Q24]
Researchers investigating MS have analysed various tissue samples from patients.
In these samples they would expect to find
C increased numbers of T helper cells in spinal fluid. (This question is about autoimmune disease not allergies or cancer. Autoimmune diseases involve increased numbers of T helper cells.)

4-118 [VCAA 2017 SA Q25]
The findings of this study are consistent with the suggestion that
D in females childhood exposure to *H. pylori* helps to protect against MS. (Males are less affected by MS and the presence of antibodies against *H. pylori* does not mean the individual has a stomach ulcer rather that the individual has been exposed to the bacterium.)

4-119 [VCAA 2014 SA Q10]
A possible cause for this weakening could be
A the transmission of electrical impulses along the axons of neurons is slowed. (Myelin acts as an insulator allowing rapid transmission of nerve impulses. Electrical impulses are all or nothing responses.)

4-120 [VCAA 2018 SA Q24]
Monoclonal antibodies can be produced and used to treat different types of cancers. Which one of the following is a correct statement about monoclonal antibodies?
B Monoclonal antibodies produced from the same clone of a cell are specific to the same antigen. (Monoclonal literally means from one clone – identical antibodies (made of protein) that are specific to the same antigen. They will attach to specific antigens on the outside of the target cancer cells.)

4-121 [VCAA 2018 SA Q35]
The emergence of antibiotic-resistant diseases in humans means that
B some bacteria are less sensitive to antibiotics. (C is definitely wrong as viruses are not treated with antibiotics. Bacteria that had a natural immunity to antibiotics survived and have become more common – they are the ones that are less sensitive to

4-122 [VCAA 2012 E1 SA Q24]
This test for HIV is reliable because the
D HIV antigen has a complementary shape specific to the HIV antibody. (This allows the HIV antigen to attach to the HIV antibody. If the antibody and the antigen had the same shape, they would not bind together.)

4-123 [VCAA 2012 E1 SA Q25]
Values below 0.300 are considered to be negative. The results of these tests suggest that
C patient S has responded to exposure to HIV by developing antibodies. (Antibodies are produced after exposure to the virus therefore patient T has been exposed. The positive control contains more antibodies than the negative control. Patient R has a reading of less than 0.300 therefore has not been exposed to the HIV antigen.)

Chapter 4: Short-answer questions

4-124 [VCAA 2019 SB Q3]

a Any two of the following:
- cuts or sores
- contact with the mucous membranes of the respiratory/digestive/reproductive systems
- sexual intercourse
- insect/animal bites

b Any one of the following:
- Complement proteins: complement proteins stick to invading pathogens, increasing identification by phagocytes. They attract phagocytes to the site of infection and stimulate their activity and some complement proteins destroy pathogen membranes.
- Stomach acid: destroys swallowed bacteria
- Protease: digest bacterial cell walls

c Histamines are released by mast cells. They increase the diameter and permeability of blood vessels increasing blood flow to the site of infection (vasodilation). This results in heat, swelling and reduced movement thereby

confining the pathogen to the area. Histamines also attract phagocytes. Phagocytes destroy the pathogen.

d Antigens on the bacteria are recognised by macrophages/dendritic cells. The macrophages/dendritic cells then engulf the bacteria, process the antigens and then display the antigens on MHCII markers. The displayed antigens are recognised by specific T helper cells.

4-125 [VCAA 2018 SB Q3]

a Any two of the following chemical barriers found in plants:

- secretion of resin at the site of infection. The resin traps and immobilises the pathogen before it can enter plant cells.
- secretion of antibiotic-like substances (phytoalexins)/fungicides/toxins/extracellular enzymes/phenolic substances. These kill the pathogens before they can enter plant cells.
- secretion of enzymes that digest pathogens.
- chemicals released by roots to attract beneficial bacteria.

b Any two of the following barriers to pathogens entering the internal environment of humans:

- the presence of an **intact** rough and impermeable skin
- the production of sebum an antiseptic that kills pathogens
- the presence of hairs/cilia and mucus lining the respiratory and digestive systems. The hairs trap and immobilise pathogens.
- the production of stomach acid/urine/vaginal secretions. The acid kills pathogens.
- the production of lysozymes in saliva and tears. These destroy/breakdown pathogens.

c Complement proteins stick to the invading pathogens, increasing identification by phagocytes. They attract phagocytes to the site of infection and stimulate their activity and some complement proteins destroy pathogen membranes. Natural Killer cells kill virus infected cells (Note that Natural Killer cells are not in the study design.).

4-126 [Adapted VCAA 2017 SB Q2]

a Any one of the following:

- thick cell wall/cuticle/thick bark. These provide a barrier stopping pathogens and insects from entering plant tissue.
- hairs/spines/prickles. These trap the pathogens and insects on the surface of the plant preventing their entry into plant tissue.
- the formation of galls. Galls are swellings that limit the movement of pathogens and insects to other parts of the plant.

b Runner A ramets are controls. They show the damage that occurs when plants are not stimulated to defend themselves against caterpillars. Any difference in in surface area eaten in runner B ramets, must be due to the prior exposure to caterpillars.

c An average surface area of 0.6 cm^2 was eaten of young ramets of Runner A compared with 0.15 cm^2 of young ramets of Runner B therefore a greater surface area was eaten of young ramets of Runner A than Runner B. (Note: numbers must be referred to.)

4-127 [Adapted VCAA 2011 E1 SB Q5]

a endocytosis or phagocytosis

b Antibodies attach to the bacteria, causing them to clump together **and** macrophages then engulf and destroy the clumped bacteria.

c Antibodies are proteins. Enzymes that break down proteins are called proteases; therefore, if the enzyme produced by the bacteria breaks down antibodies it is a protease.

4-128 [VCAA 2015 SB Q5]

a Structure A is a valve. It stops lymph flowing backwards into the lymph node.

b Any one of the following:

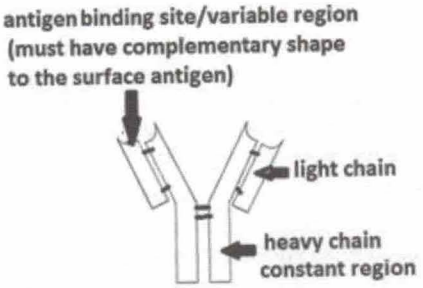
- Phagocytes: engulf and destroy pathogens/antigens.
- Mast cells: at the site of infection release histamines resulting in increased blood pressure, blood flow to the infected area, increase permeability of capillary walls and delivery of more macrophages to the site.

c B plasma cell: these produce many antibodies which tag pathogens for destruction. Antibodies are proteins and are produced by ribosomes on the rough endoplasmic reticulum.

4-129 [VCAA 2014 SB Q4]

a A pathogen is a disease-causing organism or infectious particle.

b



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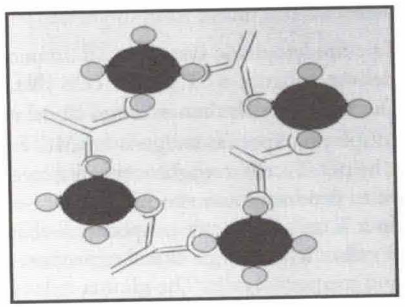


(Diagram needs to show 4 antibodies attached to at least 4 antigens)

ii Any two of the following:

- Pathogens agglutinate allowing for easier identification by phagocytes.
- The phagocytes then engulf and destroy the pathogen.
- Prevent the spread of the pathogen.
- Prevent the reproduction of the pathogen.
- Prevent the pathogen entering cells.
- Attract complement proteins.

4-130 [VCAA 2016 SB Q5]

a A vaccine is a suspension of attenuated, dead or inactivated pathogens that when injected, activates the immune system to form antibodies against the pathogen.

b After vaccination it takes time to produce specific antibodies. The antigens in the vaccine must be engulfed and displayed by macrophages. The displayed antigens then are recognised by T helper cells that then stimulate B cells that have come into contact with the antigens to divide and produce memory cells and antibody producing plasma cells.

c Name of cell type 1: Memory B cells

Role: When memory B cells come into contact with specific antigens, they are able to divide quickly into more memory cells and plasma cells that produce antibodies against the pathogen. The antibodies are then able to destroy the pathogen before the disease develops.

Name of cell type 2: Memory T cells

Role: Memory T cells survive for many years. When they come into contact with specific antigens, they stimulate specific B cells to divide rapidly into memory B cells and plasma cells that produce antibodies against the pathogen. The antibodies are then able to destroy the pathogen before the disease develops.

4-131 [VCAA 2010 E1 SB Q4]

a Strain Z. Strain Z produces the most plasma cells. Plasma cells produce antibodies which destroy the influenza virus. The greater the number of plasma cells, the greater the number of antibodies produced and thus the faster the virus is destroyed.

b Efficient vaccines are those that result in the production of the most memory cells. Blocking EB12 receptors would result in cells that act like Strain Y. Strain Y produces the most memory cells.

4-132 [VCAA 2020 SB Q5]

a Any one of the following:

- Cytotoxic T cells: release perforins/chemicals that destroy virally infected cells
- Macrophages: release tumour necrosis factors that initiate apoptosis of virally infected cells
- Macrophages or dendritic cells or phagocytes: recognise and engulf virally infected cells.

b i The role played by the lymphatic system in an immune response is to provide transport and deliver antigens to T and B cells that are concentrated in the lymph nodes. The T and B cells then undergo clonal expansion

ii Dendritic cells displaying specific antigens on MCII markers move to lymph nodes. Specific helper T cells recognise the displayed antigens and undergo clonal expansion to produce more specific helper T cells and memory T cells. The specific helper T cells then activate specific B cells that display the antigen. The activated B cells then undergo clonal expansion producing more specific plasma B cells and memory B cells. The plasma cells release specific antibodies.

4-133 [VCAA 2017 SB Q4]

a i Sterile means absence of pathogens.

ii Any two of the following:

- visitors washing their hands with antiseptic before entering a patient's room
- sterilise by heating to very high temperatures all equipment, e.g. bed pans, glass rods, forceps and containers
- using disposable swabs, bed pans
- wearing masks/gloves

b Antibodies are Y-shaped protein molecules made to a precise shape. Each type of antibody has a specific binding site at the end of each arm of the Y. The shape of this binding site is complementary to that of a specific antigen. The antigen is deactivated/immobilised/tagged for destruction by macrophages when the antigen binds to its specific antibody.

c Passive immunity. This form of immunity is beneficial to the joey as antibodies against the antigen are immediately present in the joey therefore the antigen can be destroyed quickly before the disease has time to develop. This is especially important as the joey's immune system is immature/has had no prior exposure to the antigen and has no specific B memory cells to the antigen therefore cannot produce antibodies quickly enough.

d i The innate immune response.

ii Any one of the following:

- lysozyme: catalyse the breakdown of bacterial cell walls.
- complement proteins: stick to the surface of pathogens allowing them to be identified for destruction by macrophages.
- cytokines: signalling molecules that active the immune response, e.g. Helper T cells produce cytokines that activate B plasma cells that have come in contact with a specific antigen, to divide into plasma cells and memory cells.
- venom inhibitors: molecules that bind to venom molecules thereby deactivating them.

e They would hope to find that the peptides are effective at destroying bacterial pathogens, that they can be cheaply massed produced and have no side effects on humans and therefore they can be used as a drug to fight antibiotic-resistant bacterial diseases in humans.

4-134

Reason	Explanation
Introduction of new diseases	The indigenous population had had no previous contact with many of the diseases introduced by the settlers. They therefore had no immunological memory and no immunity to the diseases.
Acquisition of land	Reduced availability of foo leading to poor health leading to poor health and increased susceptibility to disease.

4-135 [VCAA 2020 SB Q10]

a The measles outbreak is Samoa is an epidemic as it is confined to one local region. A pandemic is a global outbreak.

b Children of less than 6 months of age were less likely to die from measles as they received antibodies against measles from their mother via breast milk or placenta. Their mothers produced the antibodies as a result of surviving early contact with the measles virus or as the result of earlier vaccination.

c i 64% more five-year-old children in 2018 were vaccinated in Australian than in Samoa.

ii Artificial, active immunity

iii High vaccination rates result in herd immunity. Herd immunity is the immunity provided when most (90–95%) of the population has been immunised. This reduces the number of individuals the pathogen can infect, therefore reducing the chance that the pathogen can find a host, survive and spread to individuals not vaccinated.

d Any two of the following:
- wearing masks/gloves/glasses
- using alcohol-based sanitisers
- wipe surfaces with disinfectants
- wearing gloves
- quarantining those who have been exposed to the virus
- enforcing a lockdown.

4-136 [VCAA 2018 SB Q5]

a i 1958

ii Trends observed:
- roughly the same shape, i.e. when the number of cases increase, the number of deaths increase
- since 1968 only a few cases and deaths.

b Herd immunity is the immunity provided when most of the population has been immunised. This reduces the number of individuals the pathogen can infect, therefore reducing the chance that the pathogen can find a host, survive and spread to individuals not vaccinated.

4-137 [VCAA 2015 SB Q4]

a An effective EVD vaccine contains EVD antigens and brings about an immune response. The EVD vaccine is engulfed by macrophages that then display EVD antigens on their cell membrane. These are identified by T helper cells that then stimulate B cells that have come in contact with the vaccine to divide many times producing B memory cells and B plasma cells. The B plasma cells produce specific EVD antibodies. In the future when the person becomes infected with EVD virus, the antibodies already present along with antibodies that are produced by activated memory cells quickly destroy the EVD virus before the person develops the disease.

b The humoral response targets pathogens in tissue fluid whereas the cell-mediated response targets cells that are infected by the pathogen.

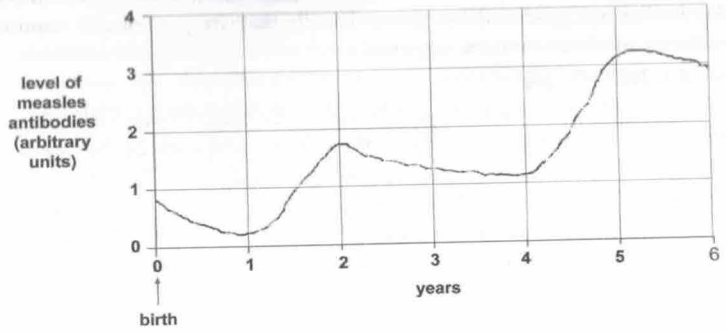
The humoral response results in B plasma cells producing antibodies which tag pathogens for destruction whereas the cell-mediated response results in the production of cytotoxic T cells which recognise and destroy infected cells.

4-138 [VCAA 2010 E1 SB Q8]

a Two years.

b If high levels of antibodies are found the child has the measles infection.
And **one** of the following:
- the child would then be isolated
- the child would be treated with gamma globin or antivirals
- the family would be vaccinated.

c



d Mrs Smith's embryo is at greater risk. Most organs of Mrs Jones' embryo are well developed therefore there is less risk of a major defect. Less organs are well developed in Mrs Smith's embryo. Mrs Smith's embryo has a poorly developed heart, arms and legs, eyes, external genitalia and ears. (Only two areas need to be referred to.) Therefore, there is greater risk of abnormalities in these areas.

4-139 [VCAA 2013 SB Q4]

a Active. Immunisation results in the child's body actively producing B plasma cells and B memory cells.

b Step 1: vaccine antigens detected by T-helper cells

Step 2: T-helper cells produce cytokines which stimulate specific vaccine antigen-displaying B cells

Step 3: The activated B cells undergo clonal expansion to produce many plasma B cells and memory cells. The plasma B cells produce and release many antibodies against the vaccine antigens.

Step 4: The presence memory cells allows the body to respond quickly when exposed to the antigen in the future

c Booster injections contain antigens that are detected by the B memory cells and T-helper cells. The T-helper cells stimulate the B memory cells to divide and produce more memory cells and plasma cells. The plasma cells then produce more antibodies. Booster injections are needed because memory cells die/short lived cells or the number of memory cells present is not enough to result in a rapid, mass production of antibodies on future contact with the antigen.

4-140 [VCAA 2012 E1 SB Q4]

a i B plasma cells

ii The four-month-old child would have a higher level of antibodies against *Bordetella pertussis* than the two-month-old child.

b The presence of memory cells will result in:
- a faster rate of production of antibodies against *Bordetella pertussis*
- a higher level of antibodies against *Bordetella pertussis*

c i Any one of the following reasons:
-the level of antibodies present in the adults is too low to provide immunity against the disease
- the adults did not receive all of the injections required for immunity
- the present infection is caused by a different strain of *Bordetella pertussis*

ii Any one of:
- advise adults to have a booster vaccination
- provide free vaccinations

d No, it is not a measure of cell-mediated immunity. Cell mediated immunity involves cytotoxic T cells. Cytotoxic T cells do not produce antibodies. Antibodies are produced by plasma B cells that are part of the humoral or antibody-mediated immune response.

4-141 [VCAA 2013 SB Q5]

a The autoantibodies attack antigens found on the person's own cells. These cells die or do not function efficiently resulting in the symptoms of the disease.

b The genetic screen indicates that the teenager has the allele that when expressed produces autoantibodies. The presence of the allele means the teenager has the potential to produce autoantibodies, but this will only occur if T-helper cells and B cells are stimulated/activated to produce the antibodies. If they have not been turned on, then no autoantibodies will have been produced so the test would be negative.

Chapter 5: How are species related over time?

5-1 The significance of meiosis:
Meiosis results in a reduction in number of chromosomes in the gametes (ova and sperm). Sexual reproduction involves the fusion of gametes. If gametes were diploid, each time fertilisation occurred the chromosome number would double. Meiosis results in gametes containing one of each pair of chromosomes. Fertilisation restores the diploid number in the new individual.
Meiosis results in variation in the offspring. Variation in populations allows species to survive changing environments. Meiosis results in new combinations of alleles, which may be expressed as new phenotypes. During meiosis the following lead to variation in gametes:
- random assortment and separation of homologous chromosomes during the first stage of meiosis
- crossing over during prophase I of meiosis.
Gametes that contain unique combinations of alleles that are different from those found in either parents' cells are the result of meiosis.
Note: Meiosis is a shuffling process and does not add new alleles to gametes. This is the role of mutation.

5-2 A gene is a specific sequence of nucleotides that codes for a specific protein. Different forms of a gene are called alleles and have differences in their genetic code that results in differences in the proteins that are produced.

5-3 The term **homologous** refers to the size and shape of chromosomes. If two chromosomes are the same length and contain genes for the same characteristics, they are homologous. (Note: The alleles of particular genes do not have to be identical.) The terms **homozygous** and **heterozygous** refer to the alleles for a particular gene carried on homologous chromosomes. If the alleles are identical, an organism is said to be **homozygous** for the alleles of that gene. If the alleles are different, the organism is described as **heterozygous**. (Remember: in this sense, 'homo' means the same and 'hetero' means different.)

5-4 The **genotype** refers to the alleles an individual possesses – literally the type of genes present. Often genotypes are written as pairs of letters. Each letter represents a member of an allele pair. For example, a genotype for eye colour is BB where 'B' represents the allele responsible for production of brown pigment. An individual with this genotype has a particular appearance or **phenotype** – in this case brown pigments in the eye. Phenotype refers to the characteristic that shows or is expressed. A particular feature might not be visibly expressed, such as the production of a particular enzyme but its presence is part of an organism's phenotype. The phenotype is influenced by the alleles inherited (genotype) and the environment. Many individuals with brown hair do not always have brown hair. An environment of excessive sun or bleaching agents may cause an alteration in phenotype even though the genetic potential is for dark hair!

5-5 Variations are the differences between organisms. In this context, it is phenotypic variation that is of interest in a population. Variations exist in visible features such as external colouring or internal functioning (for example, the ability to produce a particular enzyme).

5-6 Variations can be classified into four main groups:
- **Structural variations** are easy to observe. Differences in cats' tail shapes and sizes are due to structural differences. There are huge differences in feather patterns in pigeons. In humans, differences in ear lobes or facial features are structural variations.
- **Physiological variations** are differences in how an individual's body functions. Some individuals cope better with heat stress or have greater stamina. The ability to taste particular chemicals or see certain colours can show variation. In humans some individuals are red-green colour blind.
- **Biochemical variations.** The ability to produce pigments of a particular colour leads to different coat colour in animals. Consider the range of hair colour in cats and dogs. These differences are due to biochemical variations. Some people lack the enzymes necessary to break down the sugars in dairy products. Differing abilities to produce enzymes are biochemical variations.
- **Behavioural variation** in pets is easily observed. Some dog breeds respond well to training, while for others training is a waste of time. In the human population, many of us are right-handed, but many also are left handed.

5-7 Sources of variation include:
- Gene mutation during gamete production (introduces new alleles).
- Chromosomal mutations (changes in chromosome number or size).
- Crossing over during prophase I of meiosis (shuffle the alleles within a homologous pair of chromosomes).
- Random assortment of chromosomes during meiosis (one member of each homologous pair goes to opposite poles during meiosis I).
- Mate selection (different mates would provide different alleles).
- Gamete selection (many gametes are produced but few are involved in fertilisation).

5-8 Three types of point mutation are:
1 Substitution - replacement of one nucleotide by another.
E.g. before TT**T** AAG CCG TTG
after TT**A** AAG CCG TTG (3rd T substituted for by A)
Result: only 1 amino acid in the chain affected.
2 Addition - addition of one or more nucleotides to a DNA strand.
E.g. before TTT AAG CCG TTG
after TTT AA**A** GCC GTT G (base added to second triplet results in changes to following triplets)
Result: all amino acids coded by bases at or after the addition will be affected.
3 Deletion - removal of one or more nucleotides from a DNA strand.
E.g. before TTT AA**G** CCG TTG
after TTT AAC CGT TG (removal of the 6th base alters all later triplets)
Result: all amino acids coded by bases at or after the addition will be affected.