

2.4 CELL RECOGNITION AND THE IMMUNE SYSTEM – MARK SCHEMES

Q1.

- (a) 1. Foreign protein;
Accept glycoprotein / glycolipid / polysaccharide
2. (that) stimulates an immune response / production of antibody;

2

- (b) 1. A protein / immunoglobulin specific to an antigen;
2. Produced by B cells

OR

Secreted by plasma cells;

2

- (c) 1750(%)

1

- (d) 1. Sample 1 / before vaccination no antibody released because patients not yet encountered vaccine / antigen / virus;
Accept 'produced' for 'released'
2. (Sample 2 / primary response / after first dose) activation / clonal selection / expansion of B cells into plasma cells;
3. Plasma cells release antibodies;
4. (Sample 3 / secondary response / after second dose) memory cells produce more antibodies / produce antibodies more quickly;

4

[9]

Q2.

- (a) 1. Replacement of a base by a different base (in DNA);

1

- (b) 1. (Depends on) size / mass (of protein);
2. (Depends on) charge (of protein);
Accept for 2 marks 'Smaller / more highly charged move further'

2 max

- (c) 1. Each protein has a different tertiary structure;
2. (Each) antibody has a specific antigen / binding / variable region / site;
3. So, (each antibody) forms different antigen-antibody complex
OR
(each antibody) only binds to complementary (protein);

3

- (d) 1. Less NL3;

2. More NR2A **and** NR2B; 2
- (e) 1. Higher ratio NR2B to NR2A with mutation;
Accept 'more' as equivalent to 'ratio'
2. (Perhaps) better memory in mice with mutation; 2
- [10]

Q3.

- (a) 1. Phagosome / vesicle fuses with lysosome;
2. (Virus) destroyed by lysozymes / hydrolytic enzymes;
3. Peptides / antigen (from virus) are displayed on the cell membrane;
1. *Accept vacuole fuses with lysosome*
1. *Reject virus fuses with lysosome* 3
- (b) 1. Helper T cell / TH cell binds to the antigen (on the antigen-presenting cell / phagocyte);
2. This helper T / TH cell stimulates a specific B cell;
3. B cell clones
OR
B cell divides by mitosis;
4. (Forms) plasma cells that release antibodies;
1. *and 2. 'Helper' is required **once** only.*
2. *Accept 'This (helper) T cell stimulates a competent B cell'*
'T cell stimulates B cell to undergo clonal selection'. This statement achieves mp2 and mp3. 3 max
- (c) 1. The antibody against virus (antigen) will bind to collagen;
2. This results in the destruction of the (human) cells / collagen;
2. *Ignore 'attacks'* 2

[8]

Q4.

- (a) Has more than one / four polypeptide chains / made up of polypeptide chains; 1
- (b) 1. Antibody / variable region has specific amino acid sequence / primary structure;
2. The shape / tertiary structure of the binding site is complementary to / fits / binds with these antigens;
2. *Do not accept active site for this point.*
3. Forms complex between antigen and antibody; 3

[4]

Q5.

- (a) A = envelope/membrane/phospholipid (bilayer);

- B = capsid / nucleocapsid / capsomere / protein; 2
- (i) (HIV is) invading cells which make new viruses;
Cells release viruses into blood; 2
- (ii) Virus remains dormant/exists as provirus/exists as DNA in host DNA;
Accept virus stays in cells 1
- (c) HIV destroys T cells;
More (free) viruses produced leads to fall in T-cells;
(So fewer) T-cells activate B-cells/memory cells;
- Reduced/no antibody production;
Immune system not working properly/inability to fight infection;
Opportunistic infections;
- 4 max

[9]

Q6.

(a)

Feature	Bacterium	Human immunodeficiency virus (HIV) particle
RNA	✓	✓
Cell wall	✓	
Enzyme molecules	✓	✓
Capsid		✓

1 mark for each correct vertical column

2

- (b) 1. (Complementary) nucleotides/bases pair
OR
A to T **and** C to G;
Ignore '(DNA polymerase) forms base pairs/nucleotide pairs'
2. DNA polymerase;
3. Nucleotides join together (to form new strand)/phosphodiester bonds form;
Ignore '(DNA polymerase) forms base pairs/nucleotide pairs'
*If clearly writing rote answer about DNA replication **2 max***
e.g. helicase or separating strands

3

- (c) 1. DNA double stranded/double helix **and** mRNA single-stranded;
Contrast requires both parts of the statement
2. DNA (very) long **and** RNA short;
Accept 'RNA shorter' or 'DNA bigger/longer'
3. Thymine/T in DNA **and** uracil/U in RNA;
4. Deoxyribose in DNA **and** ribose in RNA;
R Deoxyribonucleic/ ribonucleic acid
Ignore ref. to histones
Ignore ref. to helix and straight chain alone
5. DNA has base pairing **and** mRNA doesn't/ DNA has hydrogen bonding and mRNA doesn't;

6. DNA has introns/non-coding sequences **and** mRNA doesn't;
Ignore ref to splicing

3 max

[8]

Q7.

(a) QWC

1. (Phagocyte engulfs) to form vacuole / vesicle / phagosome;
Accept surrounds bacteria with membrane
2. Lysosome empties contents into vacuole / vesicle / phagosome;
Accept joins / fuses
3. (Releasing) enzymes that digest / hydrolyse bacteria;
Ignore breakdown / destroy / lytic enzymes

3

(b) Two suitable structures;;

Examples,

1. Cell wall;
2. Capsule / slime layer;
3. Circular DNA;
Reject "circular chromosome"
4. Naked DNA / DNA without histones;
5. Flagellum;
6. Plasmid;
7. Pilus;
8. 70s / smaller ribosomes;
9. Mesosome;

2 max

[5]

Q8.

(a) (yes):
Many women (with cervical cancer) have HPV 16 (18 & 31);

(no):
Few women (with cervical cancer) have HPV 6 / 11;

(HPV infection does not mean causation because):
Could be caused by another factor / example given / may be due to coincidence;

No control group / did not study HPV in healthy women / did not study all HPV types / having cancer may increase susceptibility to HPV / does not add up to 100% / not all women with cancer have HPV / individual may have more than

one HPV type;

Neutral: correlation between HPV (16) and cervical cancer

Reject: many women with HPV 16 (18 & 31) have cervical cancer / not all women have cancer

Accept: figures from graph for 'many' and 'few'

Accept: minor errors in reading HPV frequencies from graph

Reject: does not mean HPV vaccine causes cancer;

Neutral: refs. to sample size and factors that should have been kept constant

3 max

(b) (i) Protein / glycoprotein / glycolipid / polysaccharide;

Causes immune response / antibody production;

Accept: B / T cell production

2

(ii) Memory cells produced / remain / stored (from previous infection);

Neutral: antibodies produced / remain

(When individual) comes into contact with virus / antigen (again);

Neutral: 'cell' instead of 'virus'

Reject: 'bacteria' once only

Rapid / secondary / greater response / many or more antibodies produced;

Accept: B cells / T cells

Destroys virus / antigen before it can cause harm / symptoms / cancer;

Reject: if destroys the virus / antigen in the vaccine before it can cause harm

Q Do not allow 'fights HPV'

Q Do not allow 'memory cells remember'

3 max

(c) HPV destroyed in males / prevents males being carriers of HPV;

Neutral: prevents males catching HPV

Prevents males passing on HPV (to unvaccinated females) / HPV may cause (other) cancers in males;

Accept: reference to herd effect protecting the population

2

[10]

Q9.

(a) (i) 1. (Tumour suppressor) gene inactivated / not able to control / slow down cell division;

Ignore: references to growth

2. Rate of cell division too fast / out of control.

1 and 2 Accept: mitosis

1 and 2 Reject: meiosis

2

(ii) 1. (Genetic) code degenerate;

Accept: codon for triplet

Accept description of degenerate code, e.g. another triplet codes for the same amino acid

2. Mutation in intron.

Accept: mutation in non-coding DNA

1 max

(b) 1. Antibody has specific tertiary structure / binding site / variable region;

Do not accept explanations involving undefined antigen

2. Complementary (shape / fit) to receptor protein / GF / binds to receptor protein / to GF;

Ignore: same shape as receptor protein / GF

3. Prevents GF binding (to receptor).

3

[6]

Q10.

(a) Stimulates memory cells;

Secondary response, so antivenom / antibodies produced quicker;

2

(b) Passive immunity; so no memory cells produced;

Antivenom breaks down / destroyed;

2

(c) Could transfer disease / Allergy / Immune response to antibodies from animal;

1

[5]

Q11.

(a) side effects / allergic reactions / low toxicity to cells;
interaction with other drugs / effective in conditions of use / reasonably stable;
should only act on the problem bacteria / narrow spectrum;
how much resistance the bacteria have built up;

2 max

(b) (i) tetracycline
prevents tRNA binding to ribosomes / amino acid / mRNA;

1

amino acids not available / brought / picked up;

1

chloramphenicol
prevents amino acids being joined / prevents primary structure forming;

1

no enzymes / no structural proteins formed;

(accept cell wall formation if qualified) (prevents protein synthesis gains one mark in either section, once only)

1

- (ii) only prevents tRNA binding to 70S / prokaryotic / bacterial ribosomes / human ribosomes are different sizes / shapes / structure;

1

[7]

Q12.

- (a) Microorganism alive/active;
But does not cause symptoms of disease/Avirulent;

Accept does not make you ill/harm

2

- (b) (i) (Takes time for) antigen to be recognised;
Accept reference to presentation by macrophage for first marking point

(Takes time for) T cells to be activated;

Accept primary (immune) response

B-cell activation/clonal selection/expansion;

Plasma cells to make (specific) antibodies;

Time for enough antibodies to measure;

2 max

- (ii) Memory cells (present);
Accept secondary (immune) response

Respond immediately / can produce antibodies immediately;

2

[6]

Q13.

- (a) memory B / T cells do not recognise (new antigens);
antibodies previously produced are not effective
as shape not complementary to new antigen;

2

- (b) (i) antigen in membrane presented to lymphocytes /
produce cytokinins;

1

- (ii) mitochondria provide (more) ATP / energy;
(more) RER / ribosomes synthesise proteins;
(more) Golgi body secretes / modifies or packages proteins /
produces glycoproteins;
(B lymphocytes) produces antibodies;

4

[7]

Q14.

- (a) 1. Rank all STs in ascending order;
2. Find value with same number (of people) above and below.

Accept find middle value

2

- (b) Not ethical to fail to treat cancer.

1

(c) Yes since with ipilimumab:

1. Median ST increased by 2.1 months;
2. Percentage of patients showing reduction in tumours increased from 10.3% to 15.2%;

No because:

3. No standard errors shown / no (Student) t- test / no statistical test carried out;
4. (So) not able to tell if differences are (statistically) significant / due to chance (alone);
5. Improvement might only be evident in some patients / no improvement in some patients;
6. Quality of (extra) time alive not reported;

If answers relate only to 'Yes' or 'No', award 2 marks max

4 max

- (d)
1. Faulty protein recognised as an antigen / as a 'foreign' protein;
 2. T cells will bind to faulty protein / to (this) 'foreign' protein;
 3. (Sensitised) T cells will stimulate clonal selection of B cells;
 4. (Resulting in) release of antibodies against faulty protein.

3 max

[10]

Q15.

(a) Any **two** from:

1. (Decrease linked to) few(er) cases of whooping cough;
2. (Decrease linked to) risk of / fear of side effects;
3. Insufficient vaccine available / too expensive to produce / distribute.

3. Too expensive unqualified is insufficient for mark

2 max

- (b)
1. Vaccination rate increases;
 2. Fewer people to spread the disease / whooping cough / more people immune / fewer susceptible.

2. Neutral – greater herd effect

2. Allow description of immune

Q *Reject 'resistant'.*

2

- (c)
1. More people are immune / fewer people carry the pathogen;

If neither point 1 or 2 awarded

Herd immunity = 1 mark

Unvaccinated does not mean infected

1. Q *Do not accept disease for pathogen*

2. So susceptible / unvaccinated people less likely to contact infected people.

2

[6]

Q16.

- (a) bacteria have ligands / antigens / proteins / glycoproteins / polysaccharides (on membrane / wall);

1

- complementary to receptors / fits / binds / attaches to specific receptor 1
- (b) enzymes denatured / tertiary / secondary structure altered / altered active sites / breaks hydrogen bonds; 1
- prevents named chemical reactions / metabolic pathways; 1
- (c) inhibits / kills other bacteria / fungi / decomposers / reduces competition; 1
- (d) 1 prepare a bacterial lawn / culture / sample;
(accept mix bacteria with agar / medium)
 2 with oil and one with control / water / range of concentrations;
 3 appropriate method of standardising how sample applied,
 e.g. discs / wells;
 4 appropriate measure of effectiveness / size / diameter of clear zone;
 5 the larger the zone the greater the effectiveness;
 6 use of aseptic technique;
(ignore haemocytometer) 4 max
- [9]**

Q17.

- (a) Straight lines point to point as not possible to predict intermediate values / values between points; 1
- (b) Increases then levels / falls;
 Maximum antibody production 180 units / at dose of 0.25 g per kg; 2
- (c) Two marks for correct answer of 57.14 / 57.1;;
 One mark for incorrect answer in which candidate clearly divides difference in antibody production / 60 by 105; 2
- (d) Takes into account different masses of mice / allows comparison;
Accept different weights of mice.
Do not accept different size. 1
- (e) Sheep red blood cells have antigens (on their surface);
 Antigens are proteins foreign to mice / are non-self;
 Stimulate B cells to produce antibodies; 3
- (f) Response only observed in mice;
 Disease organisms not investigated;
 Not all disease caused by pathogens / cured by antibodies;
i.e. not tested on humans 2 max
- [11]**

Q18.

- (a) 1 macrophages present antigens to B lymphocytes;

- 2 antigen binds to / is complementary to receptors on lymphocyte;
- 3 binds to a specific lymphocyte;
- 4 lymphocytes become competent / sensitised;
- 5 (B) lymphocytes reproduce by mitosis / (B) lymphocytes cloned;
- 6 plasma cells secrete antibodies;

4 max

- (b)
- 1 restriction enzyme / endonuclease;
 - 2 to cut plasmid / to form sticky ends in plasmid;
 - 3 (use) ligase(to join) gene to plasmid;
 - 4 culture bacteria with (in medium containing) plasmids
 - 5 to allow uptake of plasmids / transformation;
 - 6 use of cold shock / chemical treatment (to enhance uptake) / heat shock;
- (ignore bullets / electroporation / microinjection)*

3 max

[7]

Q19.

- (a)
1. (Releases) toxins;
 2. Kills cells / tissues.
*2. Accept any reference to cell / tissue damage
Ignore infecting / invading cells*
- (b)
1. Water potential in (bacterial) cells higher (than in honey) / water potential in honey lower (than in bacterial cells);
*Q candidates must express themselves clearly
1. Must be comparative e.g. high WP in cell and low WP in honey*
 2. Water leaves bacteria / cells by osmosis;
 3. (Loss of water) stops (metabolic) reactions.
3. Needs a reason why lack of water kills the cell

2

3

[5]

Q20.

- (a) molecule / part of molecule / protein / glycoprotein / named molecule; that stimulates an immune response / eq;
- (b) divide by mitosis / form clones; produce plasma cells; (plasma cells) make antibodies; (plasma cells) produce memory cells;
- (c)
- (i) glycoprotein AND different shape to body proteins / RNA and reverse transcriptase inside virus / phospholipids same as body's / on the surface of the virus;
 - (ii) 187.5;;
*Accept 187 – 188
1 mark for HIV = 80nm;*

2

4

1

2 max

Q21.

- (a) divide by mitosis / form clones;
produce plasma cells;
(plasma cells) make antibodies;
(plasma cells) produce memory cells;
- (b) glycoprotein;
different shape to body proteins / body phospholipids are the same /
located on the outside of the cell / the haemoglobin is located
inside the cell;

4

2

[6]

Q22.

- (a) Reverse transcriptase;
Accept integrase/description of action of
Enzyme uses (HIV) RNA to make DNA (copy);
DNA joined to (host) cell's DNA/chromosome;
DNA used to make HIV RNA (copies);
Accept (HIV) DNA replicated when (T) cell divides
And HIV capsid proteins/enzymes;
Made at (host) ribosomes;
Assembly of new virus particles;
Budding off from membrane (of host cell);
- (b) Not enough/no T-cells to activate B-cells/lead to antibody production/
activate immune system;
Accept death of T-cells weakens the immune system
Person unable to fight /more prone to (opportunistic) infections/cancer;
Accept diseases
Example of infection/cancer;
E.g. TB, pneumonia, cryptosporidium

4 max

2 max

[6]

Q23.

- (a) Zevalin/antibody binds to specific receptor/cell surface protein/antigen;
(Only found) on B-cells;
- (b) Patient **P** treated with Zevalin/yttrium (no mark);
Assume 'Zevalin' means 'with yttrium' unless they state

2

otherwise

Where indium/antibody (only) on lymphatic system/groin and armpits;

So only (cancerous) B-cells killed;

In patient **P** high concentration of radioactivity/antibodies high enough to kill cancer cells;

Patient **Q** – radioactivity in places where other body cells could be killed/ organs damaged/named example;

Could harm patient more than cancer;

Patient **Q** cancer has spread;

So too late to treat;

3 max

- (c) Patient **Q** – (cancerous) B-cells outside of lymphatic system/metastasis;

So antibody bound in other parts of the body (as well);

Patient **Q** – has different receptors/distribution of receptors compared to patient **P**;

Other body cells (than B-cells) have receptors for antibody;

2 max

- (d) Might be allergic to mouse antibody/protein;

(Mouse) antibody acts as an antigen;

Causes an immune response/antibody production;

Antibody destroys Zevalin;

Releases radioactivity into body/prevents activity against the cancer;

2 max

[9]

Q24.

- (a) Phagocytes engulf pathogens / microorganisms;

Enclosed in a vacuole / vesicle / phagosome;

Lysosomes have enzymes;

That digest / hydrolyse molecules / proteins / lipids / microorganism;

3 max

- (b) (i) Get another strain / there are different strains;

Therefore does not have memory cells against second strain;

Q *The second marking point should only be awarded in the context of memory cells.*

- (ii) Vaccines only work against certain strains because the antigens they possess are different;

Enables company to target strain likely to be prevalent later / most common strain;

2

[7]

Q25.

- (a) Damage / destruction of cells / tissues;
Production of toxins;

2

- (b) Contains antigen / proteins / dead / weakened microorganism / pathogen / virus / bacteria;
Stimulates production of antibodies / plasma cells / memory cells;

Q Do not credit immune response unless qualified.

2

- (c) (i) Age;

Sex;

Ethnicity;

All healthy / not on other medication;

Not previously vaccinated / infected with TB;

Q Do not credit sample size.

Q Allow any suitable reference to health not being affected for fourth marking point e.g. smoking, 'depressed immune system' etc.

2 max

- (ii) Contain the same antigens;

1

[7]

Q26.

- (a) (i) P = membrane / lipid envelope / phospholipid bilayer;
Q = reverse transcriptase;

Accept (host) cell membrane;

2

- (ii) Carries genetic information / to make DNA;

Q Do not accept 'information' on its own

Accept genes, alleles,

to make (viral) protein;

1

- (b) DNA copy made (of viral RNA);
Inserted into host DNA / chromosomes;
(Uses viral DNA to) make viral proteins/particles;
Makes viral RNA;
(Host) cell makes new viruses;
"Budding off" / wrapped in cell membrane;

Accept reverse transcriptase makes DNA for 2 marks in correct context;

3 max

[6]

Q27.

- (a) 1. Antigen stimulates immune response / activates B/T cells;
2. B/T cells divide OR antibodies produced;
3. Antibodies/T cells attack myelin sheaths;
Ignore references to antigen binding to myelin
- 3
- (b) 1. Fewer cristae/smaller surface area (of cristae);
2. So less electron transport/oxidative phosphorylation;
3. (So) not enough ATP produced
OR
Not enough energy to keep neurones alive;
1. Accept 'inner membrane' as 'cristae'
2. Accept fewer ATP synthase enzymes
2. Accept lower rate of electron transfer/oxidative phosphorylation
3. Accept less use/stimulation of neurone leads to death of cell
3. Accept no/less ATP produced/no energy to keep neurones alive
3. Ignore references to glycolysis/ Krebs cycle
- 3
- (c) (i) (Transmission) electron (microscope) – **no mark**
Need high resolution (to see structure of mitochondria)
Accept 'scanning electron microscope' /TEM/SEM
Accept – optical microscope not high enough resolution
- 1
- (ii) 1. Took photographs/areas at random;
2. Counted total number (of normal) and number of unusual mitochondria;
3. Divided number of unusual mitochondria by total number and multiplied by 100;
1. Accept (very) large number of areas/photos/samples
MP 3 = 2 marks (includes MP2)
- 3

[10]

Q28.

- (a) Publicity about vaccination / better health education / risks of 'flu epidemics';
(Accept: now free on NHS (though only since 2000) / better awareness / more commonly available)
- 1
- (b) (i) 1990: 26% of 7.4million = 1.92million and 2000: 64% of 7.8 million = 4.99million;
increase = 3.07 million;
- 2
- (Correct reading of all 4 figures from graph = 1)*
(Correct answer but no 'millions' = 1)
(Correct method resulting from wrong graph reading = 1)
- (ii) Over 50% of population being vaccinated;
But only from 2000 onwards;

(Principle of more people being vaccinated each year = 1)

2

- (iii) Different strain / type of virus each year / virus mutates;
With different antigens;
Influenza antibodies / memory cells (rapidly) destroyed / need replacing;

max 2

- (c) (Protein coat) carries antigens which stimulates B-cells / production of antibodies;
Production of memory cells;

2

[9]

Q29.

- (a) (i) fall in deaths due to rise in number of people with immunity / better care / targeting vaccination at vulnerable;

1

- (ii) mutation of virus / new strain;
mutant form not recognised by memory cells (*allow antibodies*);

2 max

- (b) (i) T lymphocyte receptors recognise shape of haemagglutinin / neuraminidase / viral antigen;
clone (*once only*);
destroy virus;

2 max

- (ii) clone (*once only*);
produce antibodies;
effect of antibody e.g. stimulation of phagocytosis / precipitation of toxins;

2

- (c) alter shape of active site of neuraminidase / block active site;
virus unable to leave host cells;

2

[9]

Q30.

- (a) 47 213;

1

- (b) (i) there is no difference in the proportion / number of influenza cases between the 5 vaccines;

(*reject vaccinated versus no vaccinated*)

1

- (ii) significant difference in proportion / number of cases of influenza between the vaccines / the null hypothesis should be rejected;

1

- (c) sample size small;
possible differences in exposure to infection;
exposure to different strains / mutants;
possible differences in existing immunity;
possible differences in sex / age;
possible differences in socio-economic status;

Q31.

- (a) Cotinine is an antigen;
 Antigen/cotinine binds to (specific) T-cell/activates T-cell;
 T-cell activates B-cells;
 Specific B cell becomes activated;
 (Specific) B cell divides/ clonal expansion;
 Forms (clone of) plasma cells;
 (Plasma) cell produces antibodies;
- Accept macrophage presents antigen for one mark*
Ignore references to memory cells and secondary immune response

4 max

- (b) Antibodies are proteins with tertiary structure/specific shape/binding sites;
 Antibodies specific shape for cotinine;
 Only cotinine fits;

Do not credit active site

2

Q32.

- (a) (i) To show whether immune response occurred / because cats are (genetically) related to cheetahs;
Ignore reference to control.
- 1
- (ii) To show that rejection did not normally occur / skin could (successfully) be grafted;
- 1
- (b) (i) Rapid rejection between unrelated (domestic) cats / cats are **not genetically** similar;
 Rapid rejection between (domestic) cat and cheetah / cats and cheetahs are not genetically similar;
 Slow / no rejection in cheetahs / cheetahs are genetically similar;
- 3
- (ii) Sample size small;
 Time observed was short;
- 1 max
- (iii) Similar (antigens on all cheetahs);
Accept same / not very different
- 1
- (iv) Protein / antigen production determined by alleles / genes / base sequence on DNA;
 The more similar the proteins the more similar their alleles / genes / base sequence on DNA / the more they are genetically similar;
- 2

Q33.

- (i) 1360 = 2 marks
(general principle $0.68 \div 0.05 \times 100$ gains 1 mark) 2
- (ii) still have maternal antibodies; 1

[3]

Q34.

- (a) Protein / molecule/glycoprotein;
On surface of cell/microorganism;
Stimulates immune response/production of antibodies; 2 max

- (b) Zookeeper is not producing antibodies/passive immunity;
No memory cells made;

OR

Antivenom is an antigen/stimulates production of (anti-antivenom) antibodies;
(Antivenom) destroyed by zookeeper's own antibodies;

OR

Antibody destroys antigen/venom;
Before immune response/no immune response;

2

[4]

Q35.

- (a) 1. Vaccine/it contains antigen (from HPV);
Term 'antigen' may be first mentioned with point 2
2. Displayed on antigen-presenting cells;
Accept named example, e.g. macrophage/phagocyte/B cells
3. Specific helper T cell (detects antigen and) stimulates specific B cell;
Accept 'helper T cell with receptor on surface' for 'specific' and B cells with receptor/antibody on surface that bind to antigen for 'specific'
4. B cell divides/goes through mitosis/forms clone to give plasma cells;
5. B cell/plasma cell produces antibody;

4 max

- (b) 1. Two (doses) because got more antibody;
Accept more effective in producing antibody
2. With three doses, second dose/dose at 1 month doesn't lead to production of any more antibody (than the two-dose group)/get same/similar response;
3. Three doses would be more expensive/less popular with parents/girls (and serves no purpose);

Accept 'less painful'

2 max

- (c) t-test, because comparing two means;
Mark for correct test and explanation correct
Accept 'comparing the mean'

Reject 'to show that the results/means are significant'

1

- (d)
1. Compare (base sequences of) DNA;
 2. Look for mutations/named mutations (that change the base sequence);
 3. Compare (base sequences of) (m)RNA;
1 and 3 accept triplet/codon sequences for comparisons
Ignore references to 'introns/non-coding DNA'

2 max

[9]