EXAM PAPERS PRACTICE

Cell recognition and the immune system 2

Level: CIE AS 9700
Subject: Biology
Exam Board: Suitable for all boards
Topic: Cell recognition and the immune system 2
Type: Mark Scheme

To be used by all students preparing for CIE AS Biology 9700 foundation or higher tier but also suitable for students of other boards.

Mark schemes

1

(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]

2

(a) Nucleus;

1

(b) Enables organism to remain in area (of food source) / prevent its removal;

Q *'To attach' is not sufficient unless qualified*

1

(c) (i) Correct answer of 222(%);;

Incorrect answer that clearly identifies difference in number of cases as 5800 –1800 or 5.8 – 1.8;

Correct answer gains two marks

2

(ii) More water-related activities / more 'organisms' with increased temperature;

Q *Allow any reference to growth or replication of 'organisms'. Do not penalise reference to bacteria.*

Q *Do not allow increase in water consumption.*

1

(d) (i) All have same shape / only binds to *Giardia* / one type of / specific antigen;

1

(ii) Has complementary (shape) / due to (specific) tertiary structure / variable region (of antibody);

Q *Binds / fits not sufficient unless qualified;*

1

(iii) Enzyme / second antibody would remain / is removed by washing;

Enzyme can react with substrate (when no antigen is present);

2

[9]

3

(a) Phagocytes engulf / ingest pathogens / microorganisms / bacteria / viruses;

Phagocytes destroy pathogens / microorganisms / bacteria / viruses;

Lung diseases are caused by pathogens / microorganisms / bacteria / viruses;

Q *Allow description of process of engulfing*

2 max

(b) (i) Alveoli / lungs will not inflate / deflate fully / reduced lung capacity;

Breathing out particularly affected / no longer passive;

2

(ii) Alveolar walls thicken;

Longer diffusion pathway;

Scarred / fibrous tissue;

Reduces surface area (for gaseous exchange);

Q *Diffusion is essential for 2nd point and surface area for 4th point.*

4

(c) (i) Cancer develops 20 – 30 years after exposure (to asbestos);

1

(ii) Smoking / air pollution / specified industrial source;

1

[10]

4

(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.*

2

(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]

5 (a) (i) Many people do not go to the doctor;

1

(ii) 36000;

No marks awarded for working here as calculation is very straightforward

1

(b) Same sugars / antigens on bacteria / nerve cells;

Do not accept references to same shape as equivalent to complementary.

Bind with antibody / form antigen-antibody complex;

Reject react

Have complementary shape / fit binding site;

Reject active site

3

(c) Diaphragm will not move down / flatten / contract;

Ignore references to breathing out

Thoracic cavity / lung volume not increased so cannot breathe in;

2

[7]

6 (a) molecule / part of molecule / protein / glycoprotein / named molecule; that stimulates an immune response / eq;

2

(b) divide by mitosis / form clones; produce plasma cells; (plasma cells) make antibodies;
(plasma cells) produce memory cells;

4

(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;

1

(ii) 187.5;;
Accept 187 – 188
1 mark for HIV = 80nm;

2 max

[9]

7

(a) divide by mitosis / form clones;
produce plasma cells;
(plasma cells) make antibodies;
(plasma cells) produce memory cells;

4

(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;

2

[6]

8

(a) Injection of antigens / toxoids;

(Antigen from) attenuated microorganism / non-virulent microorganisms / dead

microorganisms / isolated from microorganism;

Stimulates the formation of memory cells;

max 2

(b) (i) Antibodies are specific to mumps antigen;
2nd antibodies specific to mumps antibody;

1

(ii) Removes unbound 2nd antibodies;
Otherwise enzyme may be present / may get colour change anyway / false positive;

2

(iii) No antibodies to bind (to antigen);
Therefore 2nd antibody (with the enzyme) won't bind / no enzyme / enzyme-carrying antibody present
(after washing in step 4);

2

[7]

9

(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]

10

(a) add antibodies / enzyme;
wash to remove unbound antibodies;
add (colourless) solution;

(mark correct responses sequentially)

3

(b) antibodies specific / shape only fits one antigen;
other antigens different shape and would not bind to antibodies;

2

[5]

11

(a) (i) protein / immunoglobulin;
specific to antigen;
idea of 'fit' / complementary shape;

2 max

(ii) 1. virus contains antigen;
2. virus engulfed by phagocyte / macrophage;
3. presents antigen to B-cell;
4. memory cells / B-cell becomes activated;
5. (divides to) form clones;
6. by mitosis;
7. plasma cells produce antibodies;
8. antibodies specific to antigen;
9. correct reference to T-cells / cytokines;

6 max

(b) 1. antibody gene located using gene probe;
2. cut using restriction enzyme;
3. at specific base pairs;
4. leaving sticky ends / unpaired bases;
5. cut maize / DNA / vector using same restriction enzyme;
6. join using DNA ligase;
7. introduce vector into maize / crop / recombinant DNA into maize;

4 max

(c) passive / person is not making own antibodies / antibodies not replaced;
memory cells not produced;

2

(d) fewer ethical difficulties / less risk of infection;

1

[15]

12 (a) To prevent contamination of apparatus with other microorganisms / bacteria;
To prevent personal contact with bacteria;
To prevent release of bacteria into air;

max 2

(b) (i) Diffuses slowly;

1

(ii) B;
Produces inhibition zone greater than the minimum diameter;

2

[5]

13 (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]

14 (a) (i) protein / glycoprotein / glycolipid / polysaccharide / molecule;
on surface / membrane (of cell);
causes immune response / description / triggers antibody production;

max 2

(ii) reference to hybrid cell from tumour / cancer and B-lymphocyte / hybridoma;
antibodies all the same / from one type of plasma cell;
specific to / complementary to / fits only one antigen;

max 2

(b) (i) antibodies specific / only binds to PSA;
PSA only associated with prostate cancer / not with other diseases;

2

(ii) antibody with enzyme only attaches if PSA present / washed away if no PSA;
no colour change without enzyme;

2

[8]

15 (a) molecule (on cell surface);
that triggers immune response;

2

(b) (i) axes right way round and labelled;
2nd peak drawn higher;
steeper gradient on second rise;

3

(ii) because one dose does not give a high enough level of antibody to be effective / because the antibody falls after a while;

1

(iii) antigens are only single molecules / part of parasite;
do not actually cause disease;

2

(c) malaria sufferers would have parasites in red blood cells;

1

[9]

16 (a) Presence of resistant and non-resistant varieties / mutation produces resistant variety;
Resistant ones survive / non-resistant ones killed by treatment;
These will reproduce and produce more resistant parasites / pass on resistance allele;

3

(b) Likelihood of being infected (by strain resistant to both drugs) is less;
1/500 × 1/500/1/250 000;
Drug has longer effective life;

max 2

(c) (i) As comparison / to show that nothing else in the treatment was responsible;

1

(ii) Given injections of saline / injection without SPf66;
(otherwise) treated the same as experimental group;

2

(d) (i) 100%;

1

(ii) 10%;

1

(e) (i) Different lengths of DNA have different base sequences / cut at specific sequence;
Results in different shape / different shape of active site;
Therefore (specific sequence) will only fit active site of enzyme;

3

(ii) Recognition sites contain only AT pairs;
Which would occur very frequently;

2

[15]

17 (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]

18 (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]

19 (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]

20 (i) 1360 = 2 marks
(general principle 0.68 ÷ 0.05 x 100 gains 1 mark)

2

(ii) still have maternal antibodies;

1

[3]

21 (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]

22 (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]

23 (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;

2 max

[5]

24 (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]

25 (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);

4 max

(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

2 max

[6]

26 (a) Zevalin/antibody binds to specific receptor/cell surface protein/antigen;

(Only found) on B-cells;

2

(b) Patient **P** treated with Zevalin/yttrium (no mark);

Assume 'Zevalin' means 'with yttrium' unless they state 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]

27 (a) Correct answer: 1.25;

Ignore working

OR (if wrong answer)

$$\frac{\text{measurement in µm}}{40000} \;/\; \frac{\text{measurement in mm}}{40} = 1 \text{ mark}$$

125 but wrong order of magnitude = 1 mark

2

(ii) **C** has myosin / thick (and actin / thin) filaments;

OR

A has only actin / thin (/ no myosin / no thick) filaments;

1 max

(b) When contracted:

Thick & thin filaments/myosin & actin overlap more;

Interaction between myosin heads & actin / cross-links form;

Movement of myosin head;

Thin filaments / actin moved along thick filaments / myosin;

Movement of thin filaments / actin pulls Z-lines closer together;

Displacement of tropomyosin to allow interaction;

Role of Ca^{2+};

Role of ATP;

Allow ref. to 'sliding filament mechanism' / described if no other marks awarded

4 max

(c) (i) 8 has DMD but 3 and 4 do not / 12 has DMD but 6 and 7 do not / neither parent has the condition but their child has;

Allow parents 3 and 4 give 8, parents 6 and 7 give 12

1

(ii) 4 ***AND*** 7;

1

(iii) Parental genotypes: 6 = $\mathbf{X^DY}$ AND 7 = $\mathbf{X^DX^d}$

AND

Gametes correct for candidate's P genotypes – e.g.

$\mathbf{X^D}$ and **Y** + $\mathbf{X^D}$ and $\mathbf{X^d}$;

Offspring genotypes <u>correctly derived</u> from gametes e.g.

$\mathbf{X^DX^D}$ + $\mathbf{X^DX^d}$ + $\mathbf{X^DY}$ + $\mathbf{X^dY}$;

Male offspring with MD correctly identified: $\mathbf{X^dY}$;

Probability = 0.25 / correct for candidates offsprings genotypes;

Accept ¼ / 1 in 4 / 1:3 / 25%

NOT '3:1' / '1:4'

4

(d) (i) No gene fragment **G**;

1

(ii) Only one copy of gene fragment **F**;

Male has only one X-chromosome / is XY (c.f. female has two / is XX);

2

(iii) 10 has only one copy of gene fragment **G**;

10 has only one normal X-chromosome / has one abnormal / has only one normal allele / has one X^d / is X^DX^d / is heterozygous;

11 has two normal X-chromosomes / has 2 normal alleles / is X^DX^D / has not got X^d / has 2 copies of (F and) G;

3

(e) (i) To prevent rejection / prevent antibody production vs. injected cells / injected cells have (foreign) antigen (on surface);

1

(ii) Shows effect of <u>cells</u> / not just effect of injection / not just effect of salt solution;

1

(iii) Only one person tested so far – need more to see if similar results / need more to see if reliable;

Need to assess if new (dystrophin positive) muscle fibres are functional / if muscle becomes functional;

Can't tell how widespread effect is in the muscle / sample taken near injection site;

Need to test for harmful side effects;

Need to test if successful for other mutations of dystrophin gene;

Need to assess permanence / longevity of result/insufficient time allowed in investigation;

(In this patient) only small response / %;

Further sensible suggestion;

4 max

[25]

28 (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]

29 (a) (i) Molecule/protein/glycoprotein;
Stimulates immune response;
(That causes) production of antibodies;

2 max

(ii) Antigens on HIV are different (shape);
So, antibody will not 'fit'/not complementary (to antigen);
Receptor sites on antibody specific to one antigen;

2 max

(iii) (Has site with) same shape as salmonella antigen so binds to anti-gal antibodies;
(Has site with) same shape as receptor molecule so that HIV will bind;
Binds to both molecules;

2 max

(b) Salmonella pathogen has specific antigen on surface;
Salmonella pathogen engulfed by macrophage;
T-cells activate B-cells;
B-cell with complementary/specific receptor antibody activated/ clonal selection;
B-cells divide/form clone/clonal expansion;
Plasma cells make antibodies;
Specific to antigen/bind to salmonella bacterial antigen;

Accept macrophage presents antigen to T/B cells;

Accept T-cells release factors;

6 max

(c) (i) HIV binds to specific receptor;
Only present on certain cells / T-cells;

2

(ii) Antibiotics stop metabolism, viruses don't have metabolism;
Viruses hide in cells, antibiotics can't reach;

Two suitable cell components antibiotics work against that viruses don't have;
e.g. some antibiotics work against ribosomes, that viruses don't have

2

(d) (i) Adaptor molecule binds to HIV;
(This) prevents the HIV binding to the receptor;
Therefore few HIV available to infect cells;

2 max

(ii) Would need to be complementary to MRSA (antigens);
MRSA has different antigens;
But would still need to have binding site for anti-gal;

2 max

[20]

30 (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]

31 (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

[6]

32 (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]