



EXAM PAPERS PRACTICE

# Cell recognition and the immune system 2

Level: AQA A Level 7402

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 AQA A Level Biology 7402 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 2<sup>nd</sup> point and surface area for 4<sup>th</sup> 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 2<sup>nd</sup> antibodies;  
Otherwise enzyme may be present / may get colour change  
anyway / false positive;

2

- (iii) No antibodies to bind (to antigen);  
Therefore 2<sup>nd</sup> 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;  
 $1/500 \times 1/500/1/250\ 000$ ;  
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  $0.68 \div 0.05 \times 100$  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)

$$\frac{\text{measurement in } \mu\text{m}}{40000} / \frac{\text{measurement in mm}}{40} = 1 \text{ mark}$$

*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  $\text{Ca}^{2+}$ ;

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 =  $X^D Y$  AND 7 =  $X^D X^d$   
**AND**  
Gametes correct for candidate's P genotypes – e.g.  
 $X^D$  and  $Y$  +  $X^D$  and  $X^d$ ;  
Offspring genotypes correctly derived from gametes e.g.  
 $X^D X^D$  +  $X^D X^d$  +  $X^D Y$  +  $X^d Y$ ;  
Male offspring with MD correctly identified:  $X^d Y$ ;  
Probability = 0.25 / correct for candidates offsprings genotypes;  
*Accept 1/4 / 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  $X^D X^d$  / is heterozygous;  
11 has two normal X-chromosomes / has 2 normal alleles /  
is  $X^D X^D$  / 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 cells / 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]