Name:_____

Questions on Disease and Immunity

Directions: The following questions are taken from previous IB Final Papers on Topic 6.3 (Defence against infectious disease). Answer all questions. This will serve as a study guide for the next quiz.

Due Date: Monday April 23

1. What is a pathogen?

A. A virus that causes a disease.

B. Any organism or virus that causes a disease.

C. A disease caused by bacteria or viruses.

D. Any organism transmitted from humans to humans.

(Total 1 mark)

2. Why are antibiotics ineffective against viruses?

A. Viruses do not have metabolic pathways for the antibiotic to target.

B. Viruses have developed resistance to antibiotics.

C. Viruses destroy T-lymphocytes before the antibiotic can work.

D. Viruses mutate quickly when challenged by an antibiotic.

(Total 1 mark)

3. How do skin and mucous membranes act as barriers to infection?

	Skin	**Mucous membranes**
A.	Skin is tough and forms an effective physical barrier.	Mucous membranes are thick and elastic so pathogens are repelled.
B.	Phagocytes on the skin surface trap pathogens.	Mucus is moved out of the body by the beating of hair-like cilia.
C.	Skin is tough and forms an effective physical barrier.	Pathogens are trapped by sticky mucus.
D.	Phagocytes on the skin surface trap pathogens.	The acidity of mucus kills harmful bacteria.

(Total 1 mark)

4. Which of the following is/are necessary to produce monoclonal antibodies?

I. Tumour cells

II. Plasma (B) cells

III. Macrophages

A. II only

B. I and II only

C. II and III only

D. I, II and III

(Total 1 mark)

5. How do phagocytic leucocytes help to protect against disease?

A. They secrete bacterial toxins by exocytosis.

B. They ingest pathogens by endocytosis.

C. They produce antigens to destroy pathogens.

D. They produce antibodies to destroy pathogens.

(Total 1 mark)

6. Why are there many different types of lymphocyte in the body?

A. Each type can recognize one specific antibody and produces a specific antigen against it.

B. Each type can recognize one specific antigen and produces a specific antibody against it.

C. Each type can recognize one antigen and engulf it by phagocytosis.

D. Each type can recognize one antibody and engulf it by phagocytosis.

(Total 1 mark)

7. Which sequence of events correctly describes the destruction of pathogens in body tissues by phagocytic leucocytes?

A. Amoeboid motion → endocytosis → chemical recognition → enzymatic digestion

B. Chemical recognition → amoeboid motion → enzymatic digestion → endocytosis

C. Amoeboid motion → chemical recognition → enzymatic digestion → endocytosis

D. Chemical recognition → amoeboid motion → endocytosis → enzymatic digestion

(Total 1 mark)

8. (a) State the difference between an antigen and an antibody.

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(1)

(b) Explain antibody production.

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(3)

(c) State **two** other substances, apart from antibodies, transported by the blood.

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(1)

(Total 5 marks)

9. (a) Explain how the skin and mucous membranes prevent entry of pathogens into the body.

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(3)

(b) Explain why antibiotics are used to treat bacterial but not viral diseases.

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(2)

(Total 5 marks)

10. Describe how human skin and mucous membranes act as barriers to pathogens.

(Total 4 marks)

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(3)

(b) Explain why antibiotics are used to treat bacterial but not viral diseases.

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(2)
(Total 5 marks)

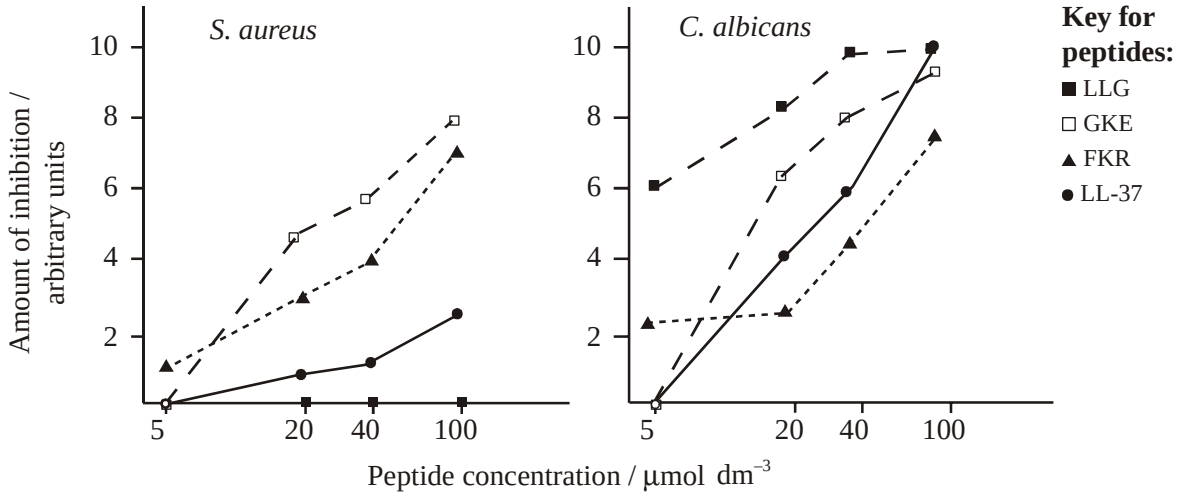
11. Explain the cause, transmission and social implications of AIDS.

(Total 8 marks)

(1)
(Total 5 marks)

12. Antibiotic peptides occur naturally on the surface of human skin. One of these peptides, called LL-37, and three other similar synthetic peptides were investigated to assess both their antibiotic properties and effect on human cells.

The graphs show the antibiotic effect of the peptides against two microbes, *S. aureus* and *C. albicans*. The technique involves measuring the inhibition of growth of the microbes.



[Source: T Sigurdardottir, *et al*., (2006), *Antimicrobial Agents and Chemotherapy*, **50** (9), pages 2983–2989]

(a) Describe the effect of the FKR on *C. albicans.*

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(2)

(b) Compare the effects of the peptide LLG on *S. aureus* and *C. albicans*.

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(2)

(c) Evaluate the effectiveness of LL-37 against the two microbes.

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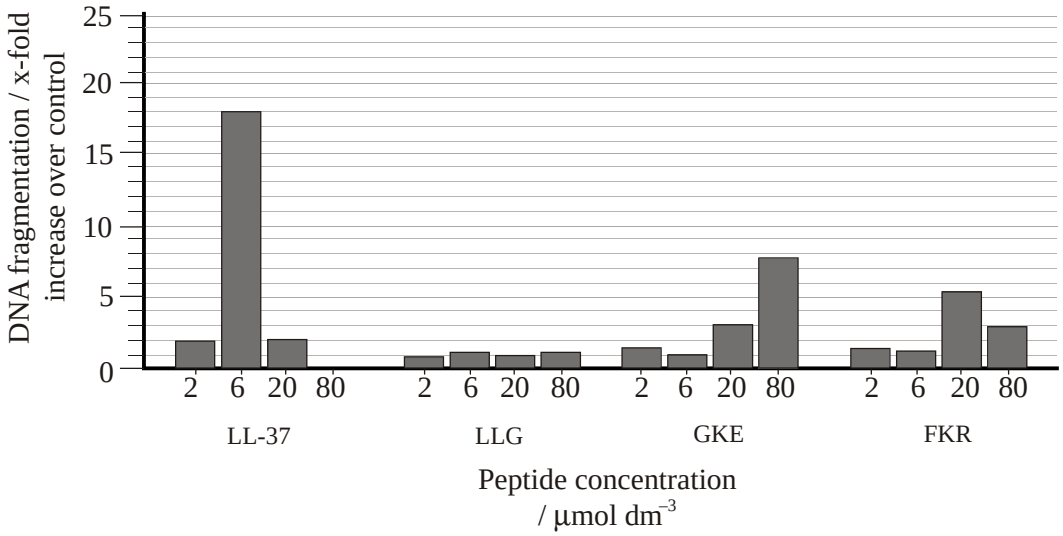
(3)

There is concern that the peptides could damage living human cells. One form of damage is fragmentation of DNA. Human cells were incubated for 16 hours with each peptide at varying concentrations. The amount of DNA fragmentation was measured.



[Source: T Sigurdardottir, *et al*, (2006), *Antimicrobial Agents and Chemotherapy*, **50** (9), pages 2983–2989]

(d) State which peptide causes the least damage to DNA.

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(1)

(e) Calculate the percentage increase in DNA damage that results when the concentration of LL-37 increases from 2 μmol dm^{-3} to 6 μmol dm^{-3}. Show your working.

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(2)

(f) Discuss the hypothesis that synthetic peptides are most suitable for controlling *S. aureus* infection inside the human body.

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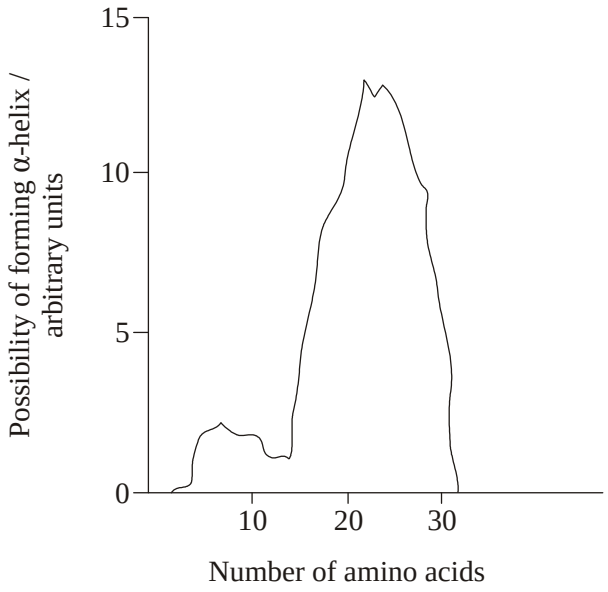
(4)

The shape of the secondary structure of a peptide can be predicted from its amino acid composition. The figure shows the theoretical likelihood of the peptide LL-37 forming an α-helix, based on the properties and position of its 37 amino acids.



[Source: T Sigurdardottir, *et al*., (2006), *Antimicrobial Agents and Chemotherapy*, **50** (9), pages 2983–2989]

(g) In addition to the α-helix, state a type of shape commonly formed as the secondary structure of proteins.

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(1)

(h) Analyse the data to determine the region of LL-37 most likely to form a helical shape.

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(2)

(i) Draw and label the structure of a peptide bond between two amino acids.

(2)

(Total 19 marks)

1. B

[1]

2. A

[1]

3. C

[1]

4. B

[1]

5. B

[1]

6. B

[1]

7. D

[1]

8. (a) *Must have both for **[1]**.*
antigen is a substance / molecule that causes antibody formation;
antibody is a (globular) protein /
molecule that recognizes an antigen; 1

(b) antigen causes an immune response to produce antibodies specific for that antigen;
antibodies produced in B-lymphocytes;
B-lymphocytes produced in bone marrow;
carried in blood;
antigen presenting cell /
helper T cell present antigen to B cell; 3 max

(c) *Must name two for **[1]**.*
CO_2;
O_2;
hormones;
named nutrient;
urea / excess ions;
platelets;
bicarbonate; 1 max

[5]

9. (a) the skin / mucous membranes act as a physical barrier;
skin has several layers of tough / keratinized cells;
the skin is dry discouraging the growth and reproduction of pathogens;
skin / mucous membranes host natural flora and fauna which compete with pathogens;
the enzyme lysozyme is present on the skin's surface to break down pathogens;
the pH of skin / mucous membranes is unfavourable to many pathogens;
skin is a continuous layer;
mucus traps pathogens / sticky; 3 max
*Award **[2 max]** if both skin and mucous membrane not mentioned.*

(b) antibiotics block metabolic pathways in bacteria / inhibit cell wall formation / protein synthesis;
viruses use host cell metabolic pathways / do not possess a cell wall and so are not affected by antibiotics;
antibiotics are not used to treat viral diseases because they are ineffective and may harm helpful bacteria; 2 max
No credit for answers that state antibiotic means against life nor for the statement that viruses are not alive.

[5]

10. *To receive full marks, responses must have **two** answers for each.*

skin:
lower pH / acid to keep bacteria from growing / chemical barrier;
fatty acids / waxes antimicrobial;
physical barrier to prevent entry / dry skin inhibits bacterial growths;
bacteria on skin / mucous membranes prevent other bacteria from growing;
antimicrobial / lysozyme in sweat and saliva (mucous membrane) to keep bacterial growth in check;

mucous membranes:
mucous traps bacteria / sticky / mucus slightly acidic *ie* vagina;
cilia sweep mucous up to be swallowed to kill bacteria;
contain macrophages / phagocytes;

[4]

11. *Responses must include reference to cause, transmission and social implications to receive full marks.*

cause:
human immunodeficiency virus / HIV / HIV 1 and HIV 2;
retrovirus / RNA to DNA;
enters T-helper cells;
immune system becomes disabled / weakened;
greater chance for opportunistic infections;

transmission:
sexually transmitted;
can be transmitted from man to woman / man to man contact / woman to man / mother to fetus;
breast milk / saliva and other body fluids;
use of dirty needles;
blood transfusions;

social implications of AIDS:
many orphaned children;
social stigma / discrimination;
problems obtaining employment / life insurance;
impact / costs on health systems of treating people;
early death reduces number of adults / reduces workforce / reduces family income;
drug treatment expensive;
reduces promiscuity / encourages use of condoms; 8 max
*(Plus up to **[2]** for quality)*

[8]

12. (a) at lower concentration inhibition is low;
as concentration rises from 5–20 μmol dm^{-3} there is very little increase in inhibition;
from 20 μmol dm^{-3} inhibition increases in a linear manner;
a valid comparison with another of the peptides; 2 max

(b) no effect on *S. aureus*, inhibits growth of *C. albicans*;
no change on *S. aureus* as concentration increases, inhibition of *C. albicans* increases with concentration; 2

(c) at lowest (experimental) concentration (LL-37) does not have effect on either;
as concentration increases so does inhibition;
greater inhibition of *C. albicans;*
effective against *C. albicans* but not / less effective on *S aureus;* 3 max

(d) LLG 1

(e) $18 - 2 = 16 / \frac{16}{2} \times 100\% / 8 \times 100\%$;

800%; 2

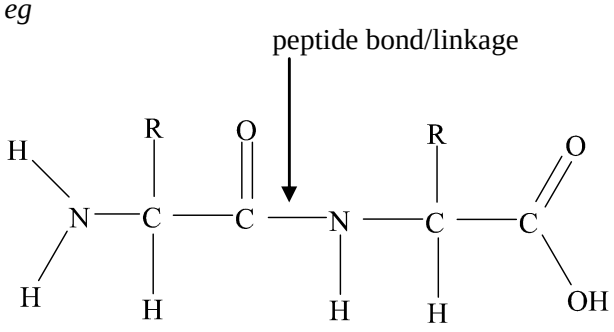
(f) LLG / naturally occurring peptide less effective;
LL-37 less effective than GKE / FKR;
LL-37 damages DNA (significantly) at more than 6 μmol dm^{-3};
LL-37 may kill cells at higher concentrations;
GKE / FKR could be used at lower concentrations;
GKE / FKR cause slight DNA damage at lower concentrations;
GKE is (slightly) more effective;
GKE causes increased DNA fragmentation at higher concentrations; 4 max

(g) β-sheet / β-pleat 1

(h) sharp peak, strong chance around 20-25;
smaller peak, strong chance at around 4-6;
no likelihood above 32 / 33 / at end of molecule;
appropriate description *eg* chance increases from 13 / 14 to 20 / 25; 2 max

(i) dipeptide showing N terminal and C terminal ends;
a hydrogen and an R group attached to each α carbon;
a link between the carbon of the C=O group of one amino acid and the nitrogen of the N-H of the other correctly labelled; 2 max

eg



[19]