Section One: Multiple-choice **30% (30 Marks)**

Question	Answer
1	d
2	d
3	d
4	d
5	c
6	a
7	d
8	b
9	a
10	a
11	c
12	b
13	c
14	c
15	d
16	b
17	c
18	b
19	b
20	c
21	b
22	d
23	d
24	c
25	b
26	c
27	c
28	d
29	a
30	c

a) Use the codon chart below to fill in the table on mutations. (4 marks)

Genetic mutation	**Amino acids**	**Effect on protein**
CACGGG ↓ CACGGC	_VAL- PROL__ ↓ VAL- PROL (1)	SYNONYMOUS/ NO EFFECT _. (1)

CAGACA ↓ CACGAC A	VAL-CYST ↓ VAL-LEU. (1)	FRAMESHIFT DUE TO INSERTION RESULTS IN CHANGE IN ALL SUBSEQUENTAMINO ACIDS_THEREFORE CHANGES ENTIRE PROTEIN (1)

b).

(i) Explain why this disease cannot be X-linked dominant. (3 marks)

Description	Marks
• either III4 or III5 is passing the defected allele to IV4. • If it were dominant, one of the parents would have to be a carrier, and if it were dominant a heterozygous carrier would be affected. • The parent (III4 and III5) genotypes would have to be X^hX^h and X^hY.	1 1 1
TOTAL	**3**

ii) Use a Punnett square to support your answer in question (i). (3 marks)

	X^h	Y
X^h	X^hX^h	X^hY
X^h	X^hX^h	X^hY

(2)

The phenotype 100% normal. Therefore, X- linked dominant mode of inheritance is not demonstrated.

c)i) Use the table of restriction enzymes to select the enzyme that could ***best*** cut the molecule into a fragment containing the helpful gene of interest. (1 mark)

*Hind*III

Note : only a sticky end cut is best

ii) Give two reasons for selecting the restriction enzyme in question (i) (2 marks)

Description	Marks
• it cuts sticky ends which is most efficient • cuts sticky ends at a site (AA)that the sequence does contain / the sequence does not have the other restriction sites • can cut outside of the gene therefore keeps the gene of interest intact.	1 1 1
TOTAL	

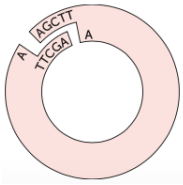
iii There is another restriction site in the DNA sequence. Name the enzyme and describe two reasons why this would not be an appropriate site to cut. (3 marks

Description	Marks
*Alu*I (any 2 below) • The restriction site matches the enzymes that make a blunt ended cut, but this would reduce the specificity and efficiency of the process. • If scientists want to control the molecule that the fragment joins to, sticky ended fragments provide that specificity. • if *Alu*I was used to cut the fragment, only part of the gene of interest would have been cut out. • No guarantees of binding with blunt ends due to only backbone binding/ unstable genes insertion.	1 1 1
TOTAL	**3**

iv) How many fragments would result from running the selected restriction enzyme along this molecule? (1 mark)

3

v) Draw a plasmid, cut with the same restriction enzyme from question (i), into one fragment, ready for ligation. Indicate, by writing the correct nitrogenous bases on the overhanging parts, the complementary bases that the gene of interest could anneal to. (3 marks



(3).

(plasmid =1, correct complimentary bases inserted=1, correct overhanging cut= 1)

Q32

a)Explain why seemingly unrelated organisms could have a high percentage of very similar genes. (3 marks)

Description	Marks
• Genes code for proteins that determine how organisms function. • Genes that suit an organism to its environment will be preserved, or conserved, while other genes around it may evolve. • Two distantly related species may share very similar gene sequences for proteins whose functions are much the same in those species.	1 1 1
TOTAL	**3**

b) Provide four (4) reasons as to why comparative genomics provides more reliable evidence for relatedness than comparative anatomy. (4 marks)

Description	Marks
• Percentage differences can be calculated by computer software programs. • Morphological comparisons are based on observation and can be subjective • Comparitvie anatomy is reliant on finding adults of the same age and sex and living in the same environment. • The fossil record is incomplete and fossils themselves may simply consist of a tooth or part of a bone.	1 1 1 1
TOTAL	**4**

(c) Compare the types of mutation in a population that result from mutation and crossing over. (2 marks)

Description	Marks
The type of variation that results from: • mutation is new variation – a new allele; a permanent change to the DNA sequence. • crossing over is a recombination of the existing alleles – no change to the DNA sequences; no new alleles.	
TOTAL	

d) What effects can isolating mechanisms have on a population? (2 marks)

Description	Marks
• Isolating mechanisms prevent individuals within a population from breeding. • They reduce the alleles in the gene pool involved so that the range of available phenotypes is restricted.	
TOTAL	

e) (i) Explain what this figure is communicating in relation to the process of evolution. (5marks)

Description	Marks

• This is a phylogenetic tree that illustrates how different organisms are related. • The basis for the tree seems to be a PAX-like gene/ mapping the pax gene in species. • This is an example of evolution at a molecular or genetic level. • Common base pair sequences in genes involved in the construction of an eye are used to map species relatedness and can be found in a variety of seemingly unrelated organisms. In this example the specific eye-building gene is referred to as the PAX gene. • This similarity in base pair sequences can be used to work out how closely related certain organisms are, hence allowing for the construction of the phylogenetic tree shown.	
TOTAL	

f) (i) Use the data to construct a phylogenetic tree for the seven pine species

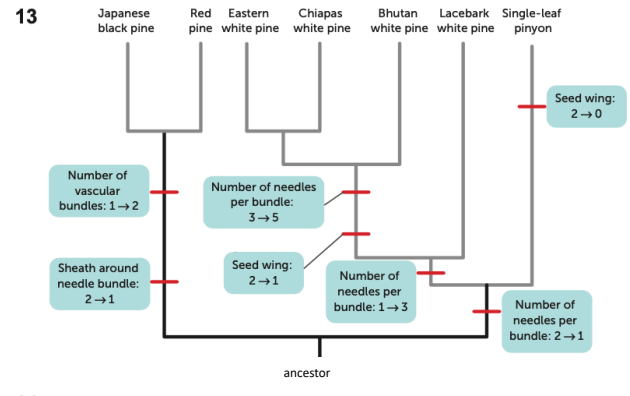
must show

Japanese black pine and red pine of same branch. (1)

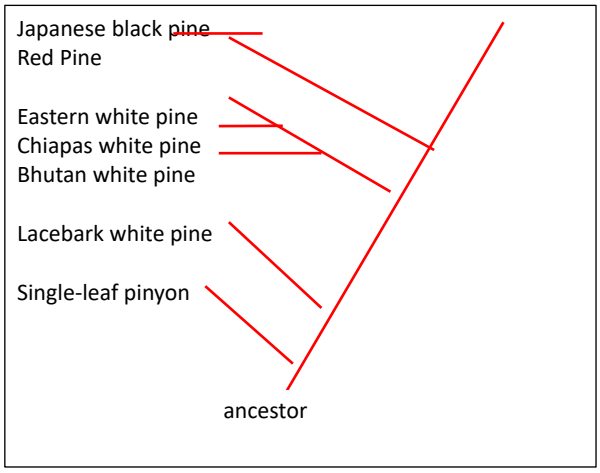
Eastern white, Chiapas white, bhutan white of the same branch. (1)

Lace bark on own branch and Single-leaf pinyon on own branch. (1)

Branches off common ancestor. (1)



or



Q33

(i) Explain four (4) ways in which an increase in nitrogenous waste may impact the organism. (4 marks)

Description	Marks
- Build up of nitrogenous waste becomes toxic - Increases the pH of body fluids - Enzyme activity is affected - Water balance is affected/ cells lose water to dilute waste	
TOTAL	

(ii) Explain four (4) ways in which transpiration supports the physiology of the plant. (4 marks)

Description	Marks

Any 4 points	
• Supplies photosynthesis/ chemical reactions with water • Water droplets cools the plant/ prevent overheating in plants • Transpiration stream distributes minerals for cellular activities • Transpiration stream distributes sugars throughout the plant for cellular respiration • Turgor pressure is maintained through distribution of water to upper leaves	
TOTAL	

(iii) Explain how stomata open and close (4 marks)

Description	**Marks**
Stomata have guard cells that open or close • Stimuli such as light, co2 and humidity cause opening /stimulate the opening and closing of stomata • Potassium ions are actively pumped into guard cells to create a concentration gradient • Guard cells then take up water by osmosis and become turgid. Outer guard cell walls are pushed away, pulling inner walls (lining stoma) apart.	
TOTAL	

(iv) List four (4) benefits to endothermy

Description	**Marks**
• body temperature can remain independent of external temperature. • enables endotherms to live in more extreme environments. • They can be active at night (when some ectotherms are not) or more often during the day/season. • Being more active may reduce the chance of predation.	
TOTAL	

(v) List four (4) benefits to ectothermy

Description	**Marks**
• Firstly, their heat source mainly comes from the environment therefore less energy requirements for these animals. • they need to consume less food. • They can spend less time hunting for food. • They can tolerate larger fluctuations in their internal body compared to endotherms.	

TOTAL	

Q34

(i) State three (3) ways in which a bacterial pathogen can harm its host. (3 marks)

Description	Marks
• After asexually reproducing inside host cells, cells may lyse and cause tissue damage. • Toxins may interfere with the normal functioning of cells. • The pathogens can lower the strength of a hosts immune system making the host more susceptible to other infectious diseases.	
TOTAL	

(ii) Describe the steps that a virus undertakes to replicate itself in a eukaryotic cell. (6 marks)

Description	Marks
• Attachment • Endocyctosis (entry) of virus nucleic acid, DNA/RNA, into host cell • DNA/RNA enters nucleus of eukaryotic host cell • Viral DNA/RNA directs host cell to replicate nucleic acid and make copies of viral proteins via translation. • New viral DNA/RNA and proteins assemble at the host's cell membrane. • Newly formed viruses exit the cell and cell may lyse (break down)	
TOTAL	

(iii) Consider the steps outlined in Q (ii) and describe two (2) points at which a virus would be susceptible to antiviral chemical therapies.

Description	Marks
• The point of attachment • the point of assembly at the cell membrane	
TOTAL	

((iv) List 3 features of viruses and bacteria that have contributed to their constant evolution (3 marks)

Description	Marks
• Quick/fast/rapid Reproduction, • high mutation rates, • transgenic ability/horizontal gene transfer	
TOTAL	

v) Viruses affect only specific host cells. Explain how this specificity comes about? (2 marks)

Description	Marks
• A virus needs to attach to specific receptor molecules on the surface of host cells. • Not all cells in a host organism contain the correct viral receptor /viral receptors are specific to certain cells	
TOTAL	

vi)Explain the different patterns of disease spread (4 marks)

Description	Marks
• sporadic disease is uncommon(infrequent) and occurs irregularly in a population. • Endemic diseases are localized to an area an occurs at a relatively constant rate. • Epidemics occur when there is an sudden rapid increase in spread of disease to wider areas or nations after an outbreak…..the disease rate above what is considered normal . • Pandemics are epidemics that spread rapidly across continents and international borders. *Nb students must have type of spread and explain spread type to be credited*	
TOTAL	

Q35

(a) Identify the independent and dependent variables in this experiment. (2 marks)

Description	Marks
independent - number of test tubes in the huddle	1
dependent - change in water temperature (°C)	1
TOTAL	**2**

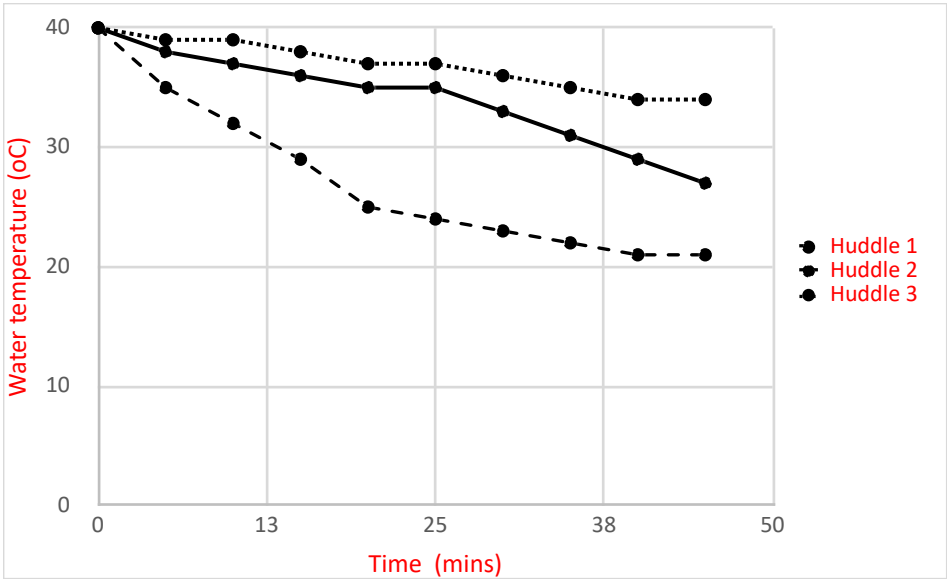
(b) Suggest a suitable hypothesis for this experiment. (2 marks)

Description	Marks
relates independent variable to dependent variable	1
Testable/ in context/suitable	1
Example; the greater the huddle size the smaller the temperature change	
TOTAL	**2**

(c) Construct a graph of the data from Table 1 in the grid provided below. (6 marks)

Description	Marks
title must include both variables	1
data plotted separately for huddles 1, 2 and 3	1
correct axes (X and Y) accurate labelling on both axes including units	1
appropriate scale	1
Key – with distinct plots	1
plotting - data plotted accurately and joined (line graph)	1
TOTAL	**6**

Title: The effect of huddle size on change in water temperature (°C) over time.



(d) Using the information presented in the graph, explain the results obtained for each test tube huddle. (6 marks)

Description	Marks
Explanation of results from each test tube huddle, **two** marks each. Examples include, but are **not restricted to**;	
• huddle 1/single test tube water temperature dropped quickly within the first 20 minutes/half of the experiment • heat was easily lost through radiation to the cooler surroundings as the single test tube was not surrounded by (insulated) by other test tubes/large SA:vol ratio	1 - 2
• huddle 2 showed a slow decrease in mean temperature in the first half of the experiment, followed by a more significant decline • increasing the number of test tubes (12) provided some insulating/ smallerSA:Vol ratio, properties for a short period of time before some heat was lost through radiation	1 - 2
• huddle 3 showed the smallest drop in temperature with a slow and steady decrease for the duration of the experiment • the larger size of the huddle (24 test tubes) provided the greatest level of insulation/Smallest SA:Vol ratio and heat was maintained by test tubes for longer	1 - 2
TOTAL	**6**

(e) State **one** change that could be made to the experimental design and explain how it could better represent penguin behaviour or environment. (2 marks)

Description	Marks
appropriate suggestion	1
explanation	1
Examples; • rotate test tubes at regular intervals to mimic real penguin movement in the huddle • place huddles in a colder environment to reflect Antarctic conditions • use fans to blow cold air at the huddles to represent conditions during a blizzard • cover with black card to simulate feathers	
TOTAL	**2**

(f) State **one** change that could be made to the experimental design and explain how it improves the reliability of the data. (2 marks)

Description	Marks
appropriate suggestion	1
explanation	1
Example; • increase the number of trials to eliminate anomalies/errors/get average • repeat whole experiment for consistency • add more varied samples to verify results	
TOTAL	**2**

Section c

36a

Perth Zoo are undertaking the task to determine the genome of some of their species. The process that is currently being used to do this has replaced its predecessor. Discuss the benefits of this process and how it outweighs the older method. (10 marks)

Description	Marks
Any 10 points	

• Old method of sequencing was Sanger sequencing
• New generation sequencing (NGS) has replaced Sanger sequencing
• the concepts behind Sanger vs. next-generation sequencing (NGS) technologies are similar. In both NGS and Sanger sequencing DNA polymerase adds fluorescent nucleotides one by one onto a growing DNA template strand. Each incorporated nucleotide is identified by its fluorescent tag.
• The critical difference between Sanger sequencing and NGS is sequencing volume.
• While the Sanger method only sequences a single DNA fragment at a time, NGS is massively parallel, sequencing millions of fragments simultaneously per run.
• NGS also offers greater discovery power to detect novel or rare variants with deep sequencing.
• The application of NGS are now widened to include conservation and agriculture
• Benefits include :
  · **Highly parallel:** many sequencing reactions take place at the same time
  · **Micro scale:** reactions are tiny and many can be done at once on a chip
  · **Fast:** because reactions are done in parallel, results are ready much faster
  · **Low-cost:** sequencing a genome is cheaper than with Sanger sequencing
  · **Shorter length:** reads typically range from 505050 -700700700 nucleotides in length	

TOTAL	

36 b
Discuss the microevolution and the different processes that can contribute to this type of evolution (10 marks)

Description	Marks

Micro-evolution characteristics. (5) • Micro-evolution is change below species level. • Micro-evolution refers to any small-scale change in the gene pool of a population • Microevolution is the change in genetic frequency of an allele in a given population. • This change arises due to a sudden and drastic alteration in the genetic variation of a population. • Speciation occurs after many accumulated micro- evolutionary changes, when one species splits into new species **Process and their Contribution to micro-evolution (5)** • Mutation- A gene or chromosome has undergone a change relative to the original gene or chromosome. • Selection (natural)- Individuals with certain inheritable traits survive and reproduce more successfully than other individuals. • Gene flow- This is the transfer of alleles that results from emigration and immigration of individuals between populations. • Genetic drift - This is a change in the gene pool of a population as a result of chance; usually occurs in small populations. • Non-random mating - Preferential mating increases the frequency of some alleles more than others. • Artificial selection- selective breeding of favourable phenotypes • Sexual Selecion- sexually dimorphic characteristics that make organisms favourable.	
TOTAL	

37 a

Compare by providing ten (10) differences between DNA replication and Transcription

Description	Marks

Differences **Transcription** **DNA replication** A single strand of mRNA is formed. Two strands of DNA are formed. Strand is built up continuously (lagging strand) built up in pieces/short lengths/Okazaki fragments. 1 strand of the DNA molecule used as a template. Each has one new strand and one from parent molecule (semi-conservative) Both of the DNA strands used as templates. DNA template is the Anti-sense or coding strand DNA template includes Leading template and lagging template strands RNA polymerase uncoils the DNA strands and breaks the weak hydrogen bonds between the base pairs. Helicase uncoils DNA and separates the two strands by breaking hydrogen bonds between bases. RNA polymerase adds RNA nucleotides. DNA polymerase (III) adds DNA nucleotides. The RNA nucleotides are A, G, C and U. The DNA nucleotides are A, G, C and T. Bases are added according to complementary base pairing / A–U and C–G. Bases according to complementary base pairing / A–T and C–G. mRNA detaches and once modified will leave the nucleus. The newly formed sister/daughter chromatids remain in the nucleus/ don't leave the nucleus until mitosis begins. Occurs in mitotic and differentiated cells. Occurs in mitotic cells. Occurs in the G1(growth phase) when proteins are synthesised Occurs in the S phase during interphase	1 mark for any correct double comparison Max 10
TOTAL	

37 (b) All species are under selection pressures. In some cases, these may lead to a species becoming extinct. In others, they may lead to the evolution of new species.

(i) Explain what is meant by selection pressures and how they can lead to extinction. (10)

Description	Marks

• Selection pressures are any factor that influence the survival of an individual, population or species.	1 1 1 1 1
• Selection pressures change the gene pool of a population by making some individuals more likely to survive and breed. • Selection pressures can decrease or increase the occurrence of a trait / allele frequency • SP reduces or increases reproductive success • Selective pressures can create competition for limited resources	1 1
• SP drives natural selection • Natural selection occurs when organisms best suited to their environment are more likely to survive and reproduce./ Organisms not surviving to reproduce cannot cope with all environmental(selection) pressures (biotic and abiotic)/ Genes that are adapted/ favourable to selective pressures will survive and those against will die off.	3 max
• Selective pressures can be stabilising,, directional or disruptive /diversifying • Stabilizing selection is a type of selection that removes individuals from both ends of a phenotypic distribution • Directional selection is a type of selection that removes individuals from one end of a phenotypic distribution • Disruptive/diversifying selection is a type of selection that removes individuals from the centre of a phenotypic distribution /favors both extremes of continuous variation.	1
• Eg of selective pressures include predation, disease, drought, … students can **explain** up to 3 Sp and effects (max 3 marks) ○ **Competition** for food, water and territories between individuals within a species or between different species. ○ **Predator/prey relationships** *in. which organisms can have favoured genes that make them mre efficient at either catching prey or avoiding predators* ○ **Sexual selection- competition for mates.** ***Sexual selection*** *occurs when individuals with particular traits are more likely to be successful than other individuals in finding a mate. It can lead to spectacular results and can produce sexual dimorphism, where males and females of a species have different forms.* ○ **Changes in environment** *that allow certain organisms with favourable genes to adapt better* ○ **Parasites/disease –** *pressure that allows the stronger immune systems/defenses to survive*	3 max 1 1 1
Extinction occurs when: • If these selection pressures changes too dramatically (eg. New disease, introduced predator) the species may not adapt. • If these selection pressures change too quickly (eg. Habitat destruction, climate change) the species may not adapt. • If multiple new selection pressures are introduced together the species may not adapt/ genetic bottlenecks may occur in depleted populations (less variations)	
total	**10**

	TOTAL	**10**

38 a

An increase in internal factors beyond the tolerance limit will potentially affect organisms.

Outline the effects on organisms when temperature, salts and water increase in the internal environment.

Description	Marks
High Temp results in : • Enzymes denature • Cells die under heat stress • Rate of photosynthesis slows • Cell membranes break down/ become fluid and lyse Too much water results in: • Inability to/interferes with regulation of salt and ion concentrations which inhibits action of ions and salts • Dilutes cytoplasm solutes which affects reactions • Decreases collisions of important cellular reactants • Lysis in animal cells Too much salts result in: • Abnormal activity in muscles and nerves • Loss of water out of cells to dilute excess surrounding salt results in cell shrinkage • Disenables water balance	Any 10 points
TOTAL	

38 b. pathogenicity and virulence can be related. Discuss these concepts and using an example, explain how pathogenicity affects virulence. (10 marks)

Description	Marks

• Pathogenicity is the capacity for a pathogen to cause disease in a host. • Virulence is the measure of severity of the disease is known as virulence. • Eg. Influenza virus changes strain each year which can involve a change in virulence factors. • The pathogenicity is very high each season due to its mode of direct and indirect transmission, • but the severity of the disease may vary from strain to strain. …….. • Some viruses have protein on their protein coat that make attachment to host cells easier. This is a virulence factor …… • because it enables replication to happen more easily …… • and therefore more cell/tissue damage…….. • Influenza has a high mutation rate and quick replication rate…… • Making it evolve all the time resulting in new strains…… • Various strains make it difficult for host immune systems to adapt/ acquire immunity without damage……..	1 1 1 1 1 1 1 1 1 1 1
TOTAL	

39a

a) A decline in internal factors outside of the tolerance limits can be detrimental to the animal. Outline the effects of a decrease in temperature, water and salts, below the tolerance limits, on an animals functioning. (10 marks)

Description	Marks
Any 10	

Decreasing temperature results in: • Decreasing enzymatic activity/ decreasing metabolism / cellular reactions • Decreasing Protein activity • Rigidity/less fluidity of membranes/ less transport of substances • Hypothermia in mammals(homeotherms) Decrease in water results in: • Inc salts impedes cell activities • Dehydration/cell shrinkage/plant cell plasmolysis • Impedes transport/flow of ions resulting in slower reactions • Impedes removal of wastes and toxins fast enough • Impedes the flow of nutrients and oxygen resulting in dec cellular respiration • Decreased medium for chemical reactions/enzymes Decrease in salts results in: • inactivity in muscles and nerves/ • irregular water balance • Decreased chemical reactants	
TOTAL	

(b) Australian Bat Lysavirus is fatal but has caused a low number of human deaths. Discuss the three interrelated factors that affect its spread and explain why the spread among humans has so far been low.

Disease spread is dependent on 3 factors and all meeting certain thresholds for effective spread./ Interrelated factors are those that depend on one another and need to occur together to have an effect.

Description	Marks
7 marks max for interrelated factors of ABLV, 3 marks max for reason for limited spread.	

• The interrelated factors are pathogen population growth, host(susceptable) population density and mode of transmission…..	1
• **growth of the pathogen population** in humans or in bats is dependent on the virus ability to replicate in host cells. (1)…….	1
• If there are few host cells in which to replicate there will be small numbers of the pathogen population , the risk of spread is very low*(1 mark)*. …….	1
• **host population density**, High density can lead to an increase in the number of susceptible hosts coming into contact with infected bats and a higher chance of transmission. …….	1
• If many people do not come into contact with many bats transmission will not occur. *(1 mark)*……..	1 1
• **Mode of transmission** in ABL is direct contact. ……	
• spread to humans by the saliva of infected bats when the saliva comes in contact with mucous membranes or broken skin, or through bat bites or scratches……	1
• If there is no direct contact there is no spread/If the mode of transmission is not suited to an actual transfer of the pathogen from bat to human, the disease cannot spread. /If humans do not get close enough for this mode of transmission to be effective, spread will stop.(1)	1 Max 7
Infection is fatal but infection in humans is low because :	
• One reason is, unlike mosquito vectors, bats do not use humans as a primary source of food, they consume insects or fruits. …….	1
• However, humans usually only come into contact with a bat/flying fox when one is injured, which is a rare occurrence. …….	1
• The **mode of transmission is a limiting factor** for this pathogen / regardless of the growth of the pathogen population humans or in bats , or the human host population density, without a more effective mode of transmission, the spread of ABL is limited.	1 Max 3
TOTAL	