ConquerHSC

Do. Believe. Conquer.

Sample HSC Biology Paper 1

Marking Guidelines & Sample Solutions

NOTE: The following sample solutions are examples of a **Band 6 response.** Depending on the marking criteria as shown below, there **MAY NOT** be a **definitive** answer to a specific question. That is, there could be **multiple answers** that satisfies **the same marking criteria or question.**

Section I Solutions

Q1) B
Q2) B
Q3) B
Q4) C
Q5) A
Q6) D
Q7) D
Q8) C
Q9) B
Q10) A
Q11) C
Q12) D
Q13) D
Q14) A
Q15) ~~A~~ D
Q16) B
Q17) C
Q18) C
Q19) D
Q20) A

ConquerHSC Notes References:

Q1 – Week 8 Notes – Module 6

Q2 – Week 1 Notes – Module 5

Q3 – Week 13 Notes – Module 8

Q4 – Week 2 Notes – Module 5

Q5 – Week 4 Notes – Module 5

Q6 – Week 2 Notes – Module 5

Q7 – Week 10 Notes – Module 7

Q8 – Week 4 Notes – Module 5

Q9 – Week 4 Notes – Module 5

Q10 – Week 2 Notes – Module 5

Q11 – Week 6 Notes – Module 6

Q12 – Week 9 Notes - Module 7

Q13 – Week 12 Notes - Module 7

Q14 – Week 5 Notes – Module 5

Q15 – Week 4 Notes – Module 5

Q16 – Week 4 Notes – Module 5

Q17 – Week 4 Notes – Module 5

Q18 – Week 9 Notes – Module 7

Q19 – Week 15 & 16 Notes – Module 8

Q20 – Week 12 Notes – Module 7

Section II Solutions

Question 21 – Sample Solution

Whole organism cloning is the process of producing a cloned offspring which can be produced using somatic cell nuclear transfer. This process can be used to produce offspring that are genetically identical to an organism with the favourable characteristics. This could potentially provide higher yield of products (lowering cost to consumers) and higher quality products. For example, merino sheep can be cloned to produce high quality wool.

One downside to whole organism cloning is that if cloning is performed on a mass scale, it could lead to a mass decline in genetic diversity and variation of the species' population. As a result, in the event of an unfavourable environment change, it could lead to species extinction and major loss to farmers that have mainly clones animals.

Comparatively, gene cloning involves making multiple copies of a gene which can done using various techniques in recombinant DNA technology such as gene splicing, PCR and DNA vector technique.

Gene cloning is essential in DNA sequencing which ultimately allows scientists to determine whether there is any SNPs or mutation that is responsible for a disease. This is critical to pinpointing the underlying DNA sequence causing diseases such as late-stage Alzheimer's Disease.

One disadvantage of gene cloning techniques does not help identify the gene of concern. Therefore, if the gene of concern is not identified, the wrong gene may be cloned and will not resolve the researcher's objective. That is, it will become a trial and error. This is not cost-efficient and time-efficient.

Overall, whole organism cloning is effective if genetic diversity is monitored & control to prevent extinction and economic loss. Gene cloning is effective if the gene of concerned is identified (i.e. known)

Marking Criteria – Question 21

1 mark = Define Gene Cloning and Whole Organism Cloning
2 marks = Advantage and Disadvantage of Whole Organism Cloning
2 marks = Advantage and Disadvantage of Gene Cloning
1 mark = Appropriate Evaluation

ConquerHSC Notes Reference:

📖 Week 8 Notes – Module 6

Question 22 – Sample Solution

Point mutation is the event where a nitrogenous base is changed at a particular locus on a chromosome, thus, only affecting one gene.

In chromosomal mutation, a section of chromosome is changed, thus, affecting more than one gene.

Mis-sense mutation is a type of point mutation where a different amino acid is specified due to substitution of a nitrogenous base. This because the modified DNA sequence has the effect of specifying for a different mRNA sequence whereby a different amino acid is specified due to altered codon sequence. Ultimately, a mutated form of protein will be produced due to abnormal polypeptide folding, altered protein shape & function. The effect of this can affect the organism physically, physiologically or behaviorally.

Chromsomal mutation can take place in the form of deletion. Deletion chromosomal mutation involves the loss of a chromosome section. If such mutation is affecting germ-line cells, the effect is that the gamete that inherits such mutated DNA sequence will have some genes that are absent. Therefore, it cannot code for some proteins that are responsible for determining physical, physiological and behavioral traits.

Marking Criteria - Question 22

1 mark = Define Point mutation and chromosomal mutation
2 marks = Effect of point mutation, distinctive from chromosomal mutation
2 marks = Effect of chromosomal mutations, distinctive from point mutation

ConquerHSC Notes Reference:

📖 Week 6 Notes – Module 6

Question 23 – Sample Solution

There are currently major two models or theories in regards to the origin and evolutionary pathway leading to modern day human civilization.

These are the replacement hypothesis (or 'out of Africa' model) and the multi-regional hypothesis. The replacement hypothesis proposes that Homo Erectus originated and migrated out of subSaharan Africa into different parts of the Old World about 2 million years ago. These Homo Erectus species then evolved independently into their own groups at different locations such as the Neanderthals in Europe. However, the modern day human (Homo Sapiens) is derived from the group of Homo Erectus that stayed and evolved independently in subSaharan Africa which was later dispersed across the world about 100,000 years ago. They then outcompeted other Homo Erectus groups such as the Neanderthals and thus occupied most of the world and evolved into modern day humans.

The oldest fossil evidence for the hominid ancestor exhibiting characeristics of modern human civilization was found in Africa 130,000 years ago. This evidence therefore supports the Out of Africa theory as we said that our direct ancestor left Africa 100,000 years ago.

The multi-regional hypothesis also proposes that the Homo Erectus group originated and migrated out of the subSaharan Africa into different parts of the Old World about 2 million years ago. During then, these Homo Erectus from different parts of the Old World evolved independently. However, the model proposes a high gene flow between the Homo Erectus groups residing in different parts of the Old World. This means that the Homo Erectus species from different parts of the Old World were able to mate with each other and their offspring would have a mix of their genes. These offsprings with mixed gene were able to evolve indepently into modern day humans in different parts of the world. Due to high gene flow, modern humans look very similar despite ancestors living in different parts of the world.

Since the father's mtDNA is broken down during fertilization, mtDNA can only be inherited from the mother. The greater the similarity between the two individuals' mtDNA, the more closely they are related. There are mtDNA of some modern human found to be derived from ancestors from South Asia rather than Africa. This appears to support the multi-regional hypothesis.

Genetistics found that the origin of modern human civilization is most likely to be derived from ancestors evolved out of Africa as proposed by the replacement hypothesis. This is because most mtDNA analysis such as the one performed on ancient Neanderthal specimen fond in Germany that differs to modern human civilization by 27 base pairs. This is larger than the typical 8 base pairs found between modern day humans. That being said, there is not sufficient evidence to completely rule out the multi-regional hypothesis.

Marking Criteria - Question 23

2 marks = Description of Multi-Regional Hypothesis including data used to support the theory

2 marks = Description of Replacement Hypothesis, including data used to support the theory.
2 marks = Correctly interprets overall conclusion pertaining to the findings from both theories

ConquerHSC Notes Reference:

📖 Week 5 Notes – Module 5

Question 24 – Sample Solution

The Ipomoea costata is an Australian plant that is susceptible to the Late Blight disease caused by the Fungus, Phytophthora Infestans.

The potato plant's pattern recognition receptors can recognize beta-glucans that is present on the fungi's cell wall as beta-glucan is a type of microbe-associated molecule pattern. When the pattern recognition receptor recognizes the beta glucans, the protease protein is produced as a response to inhibit the effectors molecules produced by the fungi's hyphae which effectively stops the growth of the fungi. This is because the protein ultimately stops the pathogen's (or the hyphae) invasion in obtain nutrients form plant's cells that are necessary for fungi growth & survival.

There are also resistance proteins that are present in the plants' cell membrane situated near the pattern recognition receptor proteins. When the resistance proteins recognizes the antigen, the proteins triggers a response via signaling pathway that result in the activation of genes in the plant that is responsible for the coding & production of enzymes, antimicrobial (phytoalexins) and oxidative molecules that help break down nuclear membrane and nucleic acid, resulting in apoptosis (cell death).

This effectively programes infected cells and surrounding cells to die in order to stop the spread of pathogens, effector molecules and the infection in general.

Marking Criteria - Question 24

4 marks = Explanation of responses and their roles to defend against named pathogen (1 mark for appropriate named response and accurate description of defence mechanism)
1 mark = Named Australian plant and appropriate pathogen

ConquerHSC Notes Reference:

📖 Week 10 Notes – Module 7

Question 25 – Sample Solution

Ethics is vital to establish the rights, wrongs, moral standards, responsibilities and justice pertaining to the use of biotechnology.

The introduction of Bt gene into crops are toxic to species such as birds, butterflies and beetles, it has consequences of reducing biodiversity and manipulating evolution.

This subject of manipulating evolution brings forth the idea of "playing as/with god" in which western religions, such as Islamic and Christian religions, strongly disapprove as regard as disrespectful. This is because, as per their religion beliefs, biotechnology involves humans intervening with God's role in creation life, dictator of death and being, thus, responsible for evolution.

Moreover, as humans are only a small category of species residing on Earth, there are questions pertaining to the equal rights other plant and animal species to survive and whether humans should dictate the survival of many categories of species?

Another ethics lies in the area of whether or not the increased global food availability and reduction nutritional deficiency used as justifications for biotechnology are actually being prioritised in supporting the people located in developing countries that require the support the most.

Another ethical issue involves biotechnology reducing biodiversity (in the form of genetic variation) with the majority of the farmers will shift towards using genetically modified food including crops and aquatic organisms having the same genes and potentially outcompeting their respective variants in the population.

At the end of the day, as outlined by the Australasian Association of Bioethics and Health Law (AABHL), it is important to encourage a wide range of stakeholders to participate in the discussion and formation of ethical policies that balances interests of all parties whilst still allowing innovation in the biotech field. It is crucial to balance the ethics of using biotechnology as a means to resolve regional or global problems.

Question 25 - Marking Criteria

6 marks = Examples of ethics implications and explanation of using biotechnology
1 mark = Assessment statement

ConquerHSC Notes Reference:

📖 Week 7 Notes – Module 7

Question 26 – Sample Solution

Lysozymes in our mouth's saliva is part of human's innate immune response as it is capable of decomposing their protective cell wall of bacteria which led to their eventual decomposition.

Phagocytes are part of the human's innate immune response. They are able to 'engulf' the antigen to inhibit its ability interact with cells. The phagocyte is then able to combine with a lysosome, which contains digestive enzymes (e.g. protease) produced by Golgi Apparatus, to breakdown the microbe or antigen.

The inflammation response, another innate immune response in humans, is initiated by infected cells releasing chemicals known as histamines and prostaglandins. These chemicals act on blood vessels causing vasodilation (e.g. dilation of blood vessel), resulting in higher level of blood flow through the site of infection. This results in increased blood temperature which slows the rate at which pathogens reproduce their enzymes and protein such as effector molecules that are required for the pathogen's invasion, survival and successful reproduction.

Question 26 - Marking Criteria

3 marks = Correct component and accurate explanation of function (1 mark for each)

ConquerHSC Notes Reference:

- 🕮 Week 10 Notes – Module 7

Question 27 – Sample Solution

A primary response is when the organism is exposed to a pathogen for the first time.

T lymphocytes have a surface receptor protein that can recognize a specific antigen. For instance, often after phagocytosis, some parts of the pathogen or antigen is relocated or moved to the surface of the phagocyte. These phagocytes will move into the lymph (fluid) whereby they will encounter lymphocytes stored in the lymph nodes.

A helper T cell will become activated if its surface receptor protein matches the antigen. This will result in the Helper T cell to clone and differentiate into cytotoxic T cells, memory T cells and suppressor T cells which all have the same specific receptor protein for the specific antigen. The cytotoxic T cells that are produced will travel towards infected cells and release cytotoxins to eliminate the infected cells which thereby destroys the antigens.

The activated helper T cells will also secrete cytokine molecules that activate B lymphocytes causing them to divide and differentiate into plasma cells and memory B cells.

The activated B cell will divide and differentiate into plasma and memory B cells. These plasma and memory B cells will also have surface antibody proteins that are specific to the antigen which the Helper T cell was activated by. These plasma cells is responsible for producing antibodies into the lymph and blood that has a surface receptor protein that is capable of binding to the specific antigen.

Vice versa, when a B cell is activated by an antigen that is specific to the B cell's surface antibody protein, the B cell can present the antigen to a Helper T cell with a specific surface receptor to the antigen. Therefore, the Helper T cell will become activated. This will result in the production of cytokines to activate more T and B cells.

Marking Criteria - Question 27

1 mark = explanation of primary response
3 marks = activation of B cell and T cells (and vice versa)
1 mark = Role of cytokines to activate B and T cells (secreted by each to activate each other)
1 mark = Explanation of how B and T cells can enable defence against pathogen.

ConquerHSC Notes Reference:

📖 Week 10 + 11 Notes – Module 7

Question 28 – Sample Solution

Gene therapy involves inserting a gene into an organism's DNA in replace a defective gene that is responsible for a disease. This is useful as it is able to assist in the prevention, control and cure of diseases

Gene therapy on individual and germ-line cells to cure diseases and disorders and remove health disparities between different ethnic and racial groups.

As gene therapy advances and becomes more refined, the results of the first few clinical trials on germ cells will be unknown and may yield adverse side-effects on the resulting offspring. This results in the ethical issue of removing the offspring's freedom of choice.

The insertion of therapeutic proteins to substitute the absence or low level of protein produced via natural, in-vivo protein synthesis due to a defective gene may be a substitute of gene therapy. These proteins functions to bind with receptors in the body to relay electrochemical messages to the hypothalamus and initial a desired response. However, therapeutic proteins could also bind with other cells' surface receptors that initiates unwanted responses. For example, EPO binds with red blood cells as well as other cells in the circulatory system that result in blood clots, heart attacks and cancer cells.

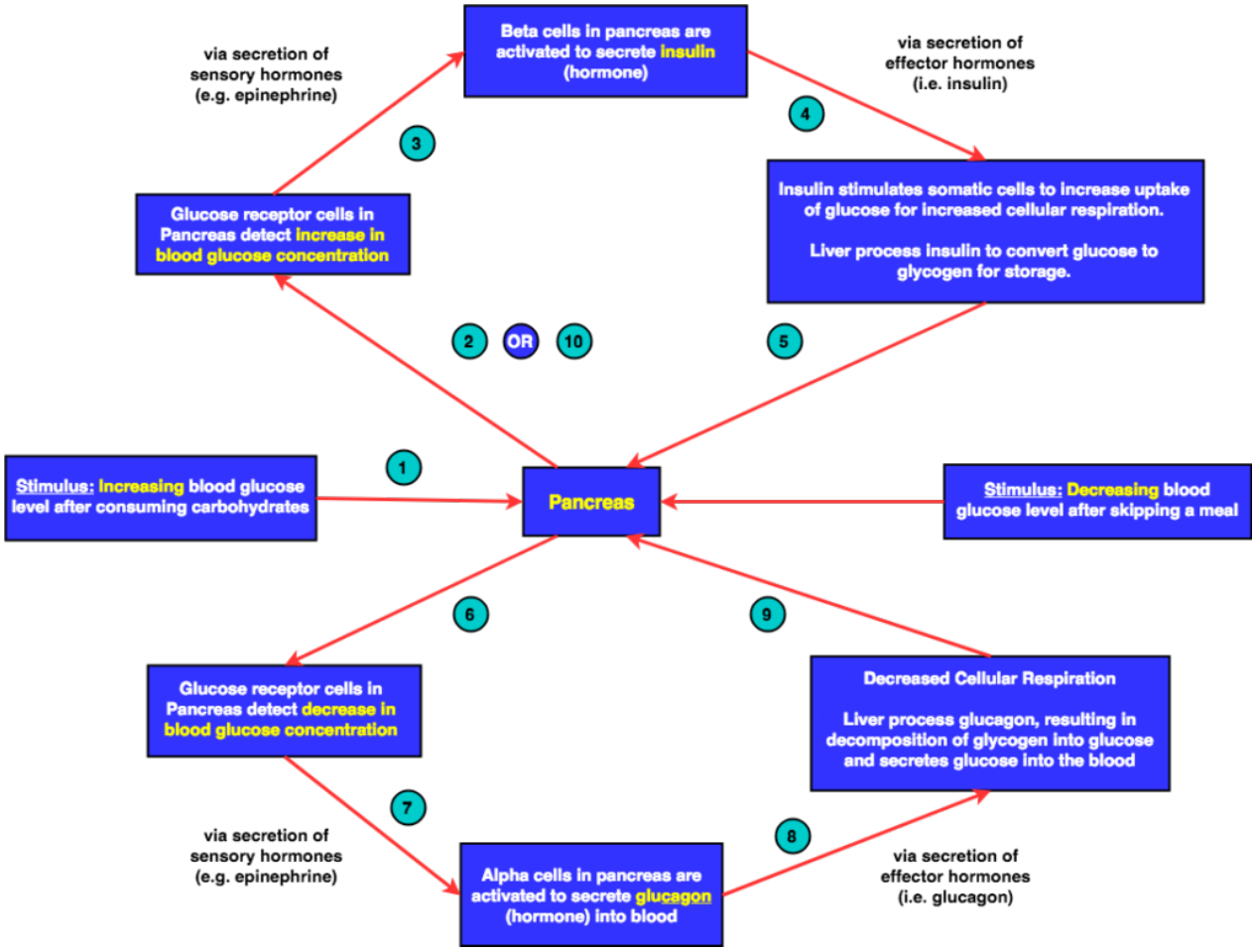
Question 28 - Marking Criteria

2 marks = Identifies two limitations and two advantages
4 marks = Explanation of limitation or advantage (1 mark each)
1 mark = Assessment statement

ConquerHSC Notes Reference:

📖 Week 7 Notes – Module 6

Question 29 – Sample Solution



Question 29 - Marking Criteria

1 mark – Receptor identified
1 mark - Control centre identified
1 mark - Sensory and effector hormones identified
2 marks - Effector and response identified
1 mark - Correct display of negative feedback loop to achieve homeostasis

ConquerHSC Notes Reference:

📖 Week 13 Notes - Module 8

Question 30 – Sample Solution

The nervous system consists of the central nervous system (CNS) and peripheral nervous system (PNS) which utilise electrochemical impulses to relay messages regarding to information such as the stimulus detected by receptors and appropriate reaction that is to be performed by effectors to counteract the stimulus and maintain homeostasis.

The way the receptor relays information about a stimulus (e.g. decrease in ambient temperature) is that it conveys physical feedback into electrochemical signals which are carried by neurons in nerves (i.e. neural pathways) to the CNS (e.g. hypothalamus). It is at the CNS where the stimulus is interpreted and an appropriate response message is produced and sent in the form of electrochemical message.

This message is transmitted via effector neurons to effectors (e.g. muscle glands) resulting in the effector to be activated upon receiving the nerve impulse (the electrochemical message). This activation or stimulation of the effector results it to carry out the appropriate response (e.g. shivering) instruct by the CNS to counteract or oppose the stimulus in a negative feedback mechanism.

Comparatively, the endocrine system employs hormones which are molecules that interact with specific receptors that are located on or within a specific target cell or tissue to initiate a response from the target cell/tissue. It is this response that allows homeostasis to be achieved and maintained.

Hormones are secreted by endocrine glands (and some minor glands) into and transported by blood. These glands secrete hormones as a response to a specific stimulus.

Hormones interact with specific receptors that are located on or within a specific target cell or tissue to initiate a response from the target cell/tissue. It is this response that allows homeostasis to be achieved and maintained.

By interacting with the receptors of the target cell or tissue, the hormone is could alter the cell membrane permeability to certain substances, modify the metabolic pathway of the cell (e.g. cause the cell to start or stop producing certain enzymes) or influence the rate of cell division.

For example, when osmoreceptors in the hypothalamus detect an increase solute concentration in the blood, it causes the pituitary gland to secrete Anti-Diuretic Hormone (ADH) into the blood stream to reach the kidneys.

It is at the kidneys whereby ADH acts on the distal tubules and collecting duct to increase their permeability to water. This increases the amount of water reabsorbed back into the blood from the kidney (water is present in the urine passing through kidney). As a result, the amount of water in the blood increases to reach osmoregulation (i.e. homeostasis in water and salt concentration in blood)

Question 30 - Marking Criteria

1 mark - Description of endocrine system including its components
1 mark - Description of nervous system including its components
3 marks - Explanation of how endocrine system achieves homeostasis with example
3 marks - Explanation of how nervous system achieves homeostasis with example

ConquerHSC Notes Reference:

📖 Week 13 Notes – Module 8

Question 31 – Sample Solution

Recombinant DNA technology is used in transgenesis which is the process of producing a transgenic species. Transgenesis start with the identification of the desired gene to be inserted into an organism. Once the desired gene is identified, FISH (fluorescence in situ hybridisation) technology is used to locate the desired gene in the organism's DNA for extraction.

The extraction process involves using the gene splicing as part of recombinant DNA technology. The technique involves using the same restriction enzyme is used to cut the DNA sequence in the organism containing the desired gene and a plasmid DNA molecule in order to transfer DNA of one species to another.

By adding heat to a solution containing the modified plasmid and E coli bacteria, the bacteria will absorb the plasmid into its DNA (process known as transformation) whereby the plasmid can be copied as the bacteria reproduces in a nutrition-rich environment

This allows multiple copies of the recombinant DNA to be produced by the bacteria (sometimes yeast is used instead of bacteria). The recombinant DNA can be inserted into a host species, which induces genetic change by inserting the desired gene, and effectively converting the organism into a transgenic species.

For example, the insertion the Bt gene (genetic change) into crops such as corn and cotton to resist crops being infected by insects and pathogens (e.g. bacteria and virus) as the gene specifies for Bt toxins proteins production.

This ultimately results in less harmful pesticides (such as insecticides) required and exposed by farmers themselves as the chemicals can cause a range of health issues from respiratory problems to cancer.

By using the technology to produce Bt crops, it helps meet the increasing demand for food for the growing world population as pathogen-resistant crops increases crop yield.

Question 31 - Marking Criteria

1 mark - Name of genetic technology
2 marks - Correct description process to induce genetic change
1 mark - The genetic change in which the process induces using an example.
2 mark – Two advantages of technology.

ConquerHSC Notes Reference:

📖 Week 8 Notes – Module 6

Question 32 – Sample Solution

Ultraviolet radiation results in two adjacent thymine bases on the **same** DNA strand form covalent bonds with each other.

As a result, the DNA double helix structure is distorted at the position of which the dimer is located. The formation of the dimer molecule prevents both of the thymine bases from bonding with adenine bases on the opposite strand as the hydrogen bonds between A=T are weakened.

In some cases, such as excessive exposure to ultraviolet radiation, it causes thymine dimers to be formed amongst adjacent nitrogenous bases in critical genes (e.g. oncogenes). This may result in uncontrollable cell growth or development, leading to skin cancer.

Lead is toxic as they can prevent substrates from binding to enzymes' active site and thus prevents normal metabolic processes from occurring in living organisms.

Also, most heavy metal bioaccumulates which means that it gets passed along in the food chain can accumulate to lethal quantities.

The infamous Minamata disaster in 1950s whereby a chemical plant in Japan released chemical waste containing large quantities mercury (a heavy metal) led to a serious disease, called

the Minamata disease. The organisms that were exposed to the large quantities of mercury were affected in many ways. Some of these included narrow vision, numbness, slurring of speech and, in severe conditions, it resulted in paralysis, loss of consciousness, convulsions, fever and death.

Question 32 - Marking Criteria

2 marks - Names of disease caused by environmental exposure
2 marks – Causes of diseases
2 marks – Effects of diseases

ConquerHSC Notes Reference:

📖 Week 14 Notes – Module 8

Question 33 – Sample Solution

Prevention measures include preventing the occurrence of disease as well as stopping its transmission and effects on society & environment when the disease occurred in nature. A preventive measure for malaria is spraying insecticides in the homes of the people at risk (known as indoor residual spraying).

Control measures deals with reducing the incidence of the disease, duration of the disease and the financial burden to affected individual, their families and affected community as a whole. So, control may be part of disease prevention strategy after the disease has occurred in nature. A control measure for malaria is following international quarantine procedures to stop the spread of disease from one area to another (e.g. one country to another).

Question 33 - Marking Criteria

2 marks - Definition of control and example
2 marks - Definition of prevention and example

ConquerHSC Notes Reference:

📖 Week 9 Notes – Module 7

Question 34 – Sample Solution

As Aboriginal people have been residing in Australia for over 65,000 years, they have acquired understanding, or intellectual property, of the medicinal or healing properties of bush medicine through interaction. It is this process of interacting with natural resources that led to the "Indigenous Ecological Knowledge" as labelled by the Australian Government.

Biotechnology companies that is performing research on creating plant-derived medicines may use books that contains records of Aboriginal People's method of using various traditional techniques and knowledge on using various flora as medicine to treat diseases that are passed down over many generations. Therefore, it is important to recognise the intellectual property of Aboriginal People that biotechnology companies use in their final product attribute credits to all contributors and ensure fairness.

Aboriginal People are insisting that scientists working for biotechnology companies are submitting their patents claim for their new plant-derived medicines which contains information sourced from them directly during the research and development process.

The process of submitting a patent claim is expensive and may not be affordable for individuals such as a single Aboriginal person. Comparatively, biotechnology companies have access to capital from investments, allowing them to have enough funding to submit a patent claim. As a result, the Aboriginal People may not receive the monetary benefit that they otherwise could have. It is important to protect the intellectual property of Aboriginal people to ensure fairness and equity.

Question 34 - Marking Criteria

2 marks - Explanation of importance of recognising IP of Aboriginal People with example
2 marks - Explanation of importance of protecting IP of Aboriginal People with example
1 mark - Description of Intellectual property of Aboriginal people

ConquerHSC Notes Reference:

📖 Week 12 Notes – Module 7