THE SCHOOL FOR EXCELLENCE (TSFX)

UNIT 3 BIOLOGY 2010

WRITTEN EXAMINATION 1

Reading Time: 15 minutes
Writing Time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of Booklet

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*	*Suggested times (minutes)*
A	25	25	25	30
B	8	8	50	60
Total			75	90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is allowed in this examination.

Materials supplied

- Question and answer book.

Instructions

- Write your name in the space provided on this page.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for the multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other electronic communication devices into the examination room.

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Please ensure that the paper size on your printer is selected as **A4** and
that you select "**None**" under "Page Scaling".

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SECTION A – MULTIPLE CHOICE QUESTIONS

Instructions For Section A

Answer all questions in pencil on the answer sheet for multiple-choice questions. A correct answer scores 1, an incorrect answer scores 0. Marks will **not** be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

QUESTION 1
It is widely known that cholesterol is a major cause of cardiovascular disease, however, this molecule also performs vital roles within the human body. These roles include:

A Acting as precursor molecules to steroid hormones such as testosterone and adrenalin.
B Assisting in cell-cell recognition.
C Acting as a primary energy store once glycogen levels have been depleted.
D Assisting in membrane stability at 37^{o}C.

QUESTION 2
One of the most important biological molecules is the phospholipid. Phospholipids:

A Form solid membrane structures in all living cells.
B Consist of a phosphate group with three fatty acid tails.
C Can possess saturated and/or unsaturated fatty acid tails.
D Are only located in animal cell membranes.

QUESTION 3
Cells of the human body are specialised for the particular roles that they play. A cell which contains very large quantities of rough endoplasmic reticulum would be a:

A Skin cell.
B Plasma cell.
C Skeletal muscle cell.
D Cartilage cell.

QUESTION 4
The synthesis and transport of insulin (a peptide hormone) in a beta cell of the pancreas involves a variety of organelles. The following sequence depicts the order in which the relevant organelles would be involved:

A rough ER → ER vesicle → golgi body → golgi vesicle → cell membrane.
B smooth ER → ER vesicle → golgi body → golgi vesicle → cell membrane.
C golgi body → golgi vesicle → rough ER → ER vesicle → cell membrane.
D rough ER → ER vesicle → golgi body → lysosome → cell membrane.

QUESTION 5
Enzymes are responsible for catalysing cellular reactions. Many of these reactions would still occur without the presence of enzymes, however, the rate of these reactions would be too slow to maintain survival of the body cells.

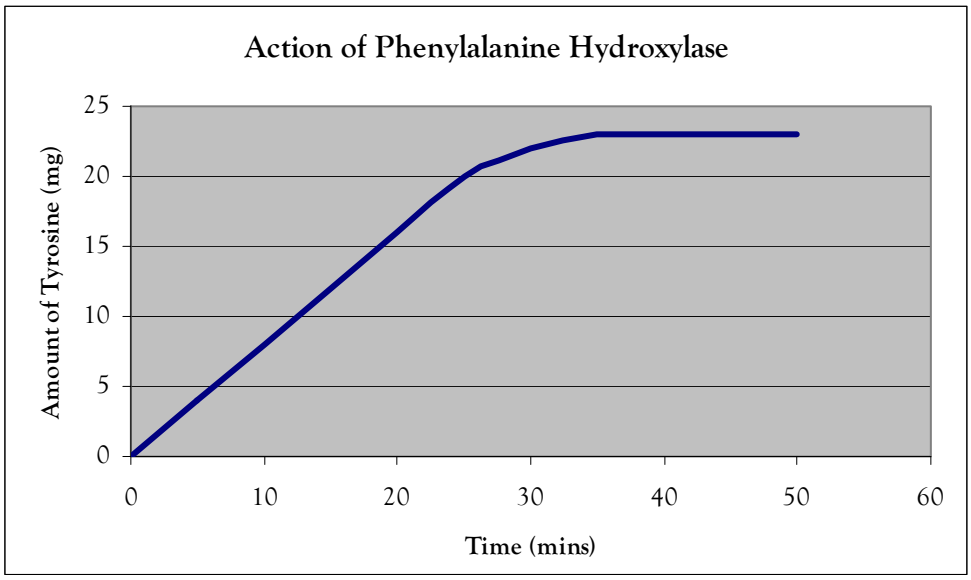
In some boating accidents, sailors have died after prolonged exposure to the cold waters of Bass Strait. News services often report on their deaths from drowning, when in reality, many of the deaths have resulted from hypothermia, a condition in which body temperature has fallen to dangerously low levels.

How does long term exposure to cold water affect enzyme function?

A Movement of enzyme and substrate molecules is irreversibly slowed down.
B Enzymes are denatured with subsequent destruction of their active sites.
C Enzymes are denatured due to a break down of their primary structure.
D The motion of enzyme and substrate molecules is reduced.

Questions 6 and 7 relate to the following graph:

The enzyme phenylalanine hydroxylase converts the amino acid phenylalanine to tyrosine. Under optimal conditions of temperature and pH, an experiment was conducted in which this reaction was observed over a 50 minute period.



QUESTION 6
From the graph it can be assumed that:

A All enzymes had denatured after 35 minutes.
B The rate of reaction remained constant after 35 minutes.
C Enzyme inhibitors had influenced the rate of reaction.
D No more substrate was available after 35 minutes.

QUESTION 7
The rate of reaction could be further increased by:

A Adding more tyrosine to the solution.
B Adding more phenylalanine to the solution.
C Adding more phenylalanine hydroxylase to the solution.
D Increasing the temperature of the solution.

QUESTION 8
The table below represents some of the stages involved in respiration. Which is the most accurate representation of any stage?

	Stage	Site	No. ATPs Produced/Glucose
A	Glycolysis	Cytoplasm	2
B	Lactic Fermentation	Cytoplasm	2
C	Krebs Cycle	Cristae	2
D	Electron Transport Chain	Cristae	36

QUESTION 9
The process of photosynthesis involves both the light dependent and light independent reactions. Which of the following statements regarding these reactions is true?

A Oxygen and ATP molecules produced in the light dependent reactions are requirements for the light independent reactions.
B NADH and ATP molecules produced in the light independent reactions are requirements for the light dependent reactions.
C NADH and oxygen molecules produced in the light independent reactions are requirements for the light dependent reactions.
D NADH and ATP molecules produced in the light dependent reactions are requirements for the light independent reactions.

QUESTION 10
The light independent reactions occur:

A In the stroma.
B On the grana.
C In the cytosol.
D In the matrix.

QUESTION 11
During photosynthesis, rubisco is the enzyme responsible for grabbing CO_2 from the atmosphere in:

A CAM plants.
B C_3 plants.
C C_4 plants.
D C_6 plants.

QUESTION 12
The endocrine system contains ductless glands which secrete their hormones into the bloodstream before they reach their target cells. A water-soluble hormone of the endocrine system includes:

A The peptide hormone insulin.
B The thyroid amino acid derivative thyroxin.
C The steroid oestrogen.
D The neurotransmitter acetylcholine.

QUESTION 13
Certain hormones do not travel in the bloodstream to reach their target cells. In some cases, the hormone travels in extracellular fluid to reach neighbouring target cells. This type of signalling is known as:

A Autocrine signalling.
B Paracrine signalling.
C Proximal signalling.
D Synaptic signalling.

QUESTION 14
Tiny quantities of a hormone cause profound responses in target cells. In the case of a signal transduction pathway within a liver cell, for instance, one molecule of adrenalin causes the release of 100,000,000 molecules of glucose.

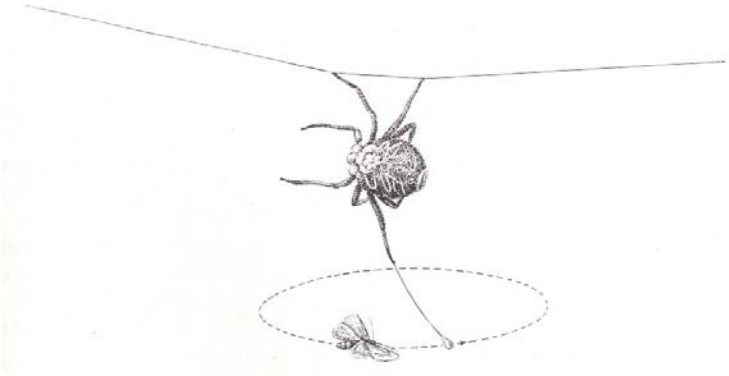
The change in the number of molecules involved at most subsequent steps in a signal transduction pathway is known as:

A Magnification.
B Amplification.
C Translation.
D Reception.

QUESTION 15
Endorphins are neurotransmitters which reduce the chances of impulses travelling along pain pathways to the brain. The ultimate effect of endorphins would be to:

A Hyperpolarise the membrane of the post-synaptic cell.
B Enhance the effect of excitatory transmitters at the synapse.
C Attach to excitatory neurotransmitters before they reach the post-synaptic membrane.
D Act as competitive inhibitors for the enzymes responsible for digesting neurotransmitters at the synapse.

QUESTION 16
The bola spider of Australia has a unique technique for capturing its prey. It laces a sticky globule (a bola) with the scent of a female moth, and dangles and twirls the bola from a silky thread in order to attract unsuspecting male moths. If the technique has proven unsuccessful for a period of time, the spider hauls in the bola, only to produce a new one that is laced with the scent of a female of a different moth species.



(Alcock J, 1979)

The chemical scent used by the spider is:

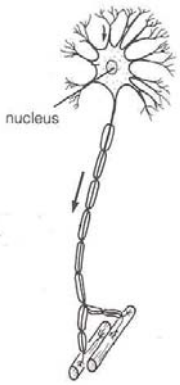
A A pheromone.
B A hormone.
C Neurohormone.
D A cytokine.

QUESTION 17
Action potentials (nerve impulses) can pass along all neuron membranes. The following events occur during an action potential:

A Electrons jump from one node of Ranvier to another along myelinated axons.
B Sodium ions rush into the cell via facilitated diffusion.
C Sodium ions actively rush into the cell via sodium-potassium pumps.
D Potassium ions rush into the cell via facilitated diffusion.

QUESTION 18
What type of cell is shown in the diagram?

A A sensory neuron with a receptor.
B An interneuron.
C A sensory neuron with an effector.
D A motor neuron with an effector.



QUESTION 19
The second line of defence of the body involves the activity of both cells and molecules. Which of the following are molecules involved in the second line of defence?

A Complement proteins.
B Antiseptics in sebaceous fluid (sebum).
C Phagocytes.
D Lysozyme enzymes found in tears.

QUESTION 20
When cattle, and then humans, began to reveal symptoms of Mad Cow Disease in Europe, many scientists and health professionals suspected a viral cause of the condition. Examination of many victims, however, failed to reveal a viral cause.

Only after further intensive examination was the real cause of the disease identified. Misfolded pieces of protein in brain cells *(proteinaceous infectious particles* or *prions)* were spread by the insidious practice of grinding up the infected brain and spinal cord tissue of animals from abbatoirs, mixing the tissue with grain, and feeding it back to cattle in feed lot farms.

Unlike most proteins, these prions:

A Do not contain amino acid subunits.
B Are not normally found in nature.
C Do not denature when superheated.
D Contain nucleotide side chains along their polypeptide strands.

The following information refers to Questions 21 and 22:

HIV (Human Immunodeficiency Virus) is a retrovirus that causes the disease AIDS (Acquired Immune Deficiency Syndrome), and years after its discovery, AIDS still causes more human deaths than any other infectious disease.

QUESTION 21
Retroviruses:

A Must produce their own DNA inside the host cell before they can reproduce.
B Contain DNA surrounded by a protein coat.
C Do not require the host cell DNA in order to reproduce.
D Primarily attack bacteria in the form of bacteriophages.

QUESTION 22
Due to the type of cells attacked by HIV, without treatment, AIDS sufferers pass away within a short time after symptoms of the disease become evident.

The main cells attacked directly by HIV are:

A Natural killer cells and mast cells.
B Macrophages and helper T cells.
C Cytotoxic T cells and B cells.
D Natural killer cells and cytotoxic T cells.

QUESTION 23
Which of the following events most directly involves the third line of defence?

A Natural killer cells directly attack cancer cells and viral-infected cells.
B Interleukin-1 released by helper T cells activates cytotoxic T cells and B cells.
C Interleukin-2 released by macrophages starts a fever response by the hypothalamus.
D Dendritic cells lying close to the external environment produce antibodies when exposed to antigens.

QUESTION 24
Allergic conditions result from the exaggerated response of the body to otherwise harmless antigens. There is a greater incidence of allergies today than at any other known time in history. This may be due to the increased incidence in the range of synthetic molecules, such as plastics, in our living environment. Another possible cause is the actions of over protective parents in not allowing their children to play in 'dirty' surroundings, thereby preventing the full development of the child's immune system at a critical age.

At the cellular level, allergic reactions occur when:

A Ig A antibodies attach to macrophages after the first allergen exposure, with the subsequent release of excessive quantities of histamine.
B Mast cells release excessive quantities of histamine after allergens attach to Ig A antibodies on their cell membrane.
C Mast cells release large quantities of histamine after allergens attach to Ig E antibodies on their cell membrane.
D Interferons, released by allergen-affected mast cells, are used to warn other body cells to produce large quantities of histamine.

QUESTION 25
Glivec is a drug specifically designed to treat myeloid leukaemia. It is a specific inhibitor for a defective enzyme (a faulty tyrosine kinase) in a signal transduction pathway within particular white blood cells. Blocking the pathway prevents the uncontrolled cell division of the white blood cells (leukaemia).

The development of *Glivec* is an example of:

A Rational drug design.
B Trial and error drug research.
C Gene technology.
D A monoclonal antibody.

SECTION B – EXTENDED RESPONSE QUESTIONS

Instructions for Section B

Answer this section in **pen.**
Answer all questions in the spaces provided.

QUESTION 1
Silk emitted by *Bombyx mori* (silkworms) consists of sericin and fibroin. Fibroin being the structural center of the silk, and serecin being the sticky material surrounding it. The fibroin protein consists of layers of antiparallel beta sheets.

(a) Draw a monomer that would combine to form fibroin.

1 mark

(b) What level of molecular organisation is a beta-folded sheet?

_____

1 mark

(c) Of what importance is it for silkworms to have their silk molecules packed in a beta folded sheet?

_____

_____

_____

1 mark

(d) Fibroin is a fibrous protein. List two ways it differ from a globular protein in terms of molecular properties?

_____

_____

_____

_____

2 marks

(e) Sericin is a glycoprotein. How would the molecular properties of sericin enhance its function?

_____

_____

_____

2 marks

Total 7 marks

QUESTION 2

Fluorescein diacetate (FDA) is a non-fluorescent and slightly soluble molecule which can pass through the plasma membrane where, in a living cell, it is then converted by an enzyme into a fluorescent molecule. A different stain, propidium iodide (PI) is a red fluorescent molecule that binds to DNA. It cannot pass across the intact plasma membrane of a living cell.

(a) The plasma membrane is selectively permeable to FDA and PI. Explain what this means.

_____

_____

_____

2 marks

(b) Describe how FDA crosses the plasma membrane.

_____

_____

2 marks

(c) Why are enzymes important for the conversion of FDA into a fluorescent molecule?

_____

_____

_____

1 mark

Currently FDA/PI staining is used in the assessment of viability for human transplant. A patient is considered fit for transplantation when viability is above 70%.

(d) Suggest why this method of assessment is useful in such cases.

_____

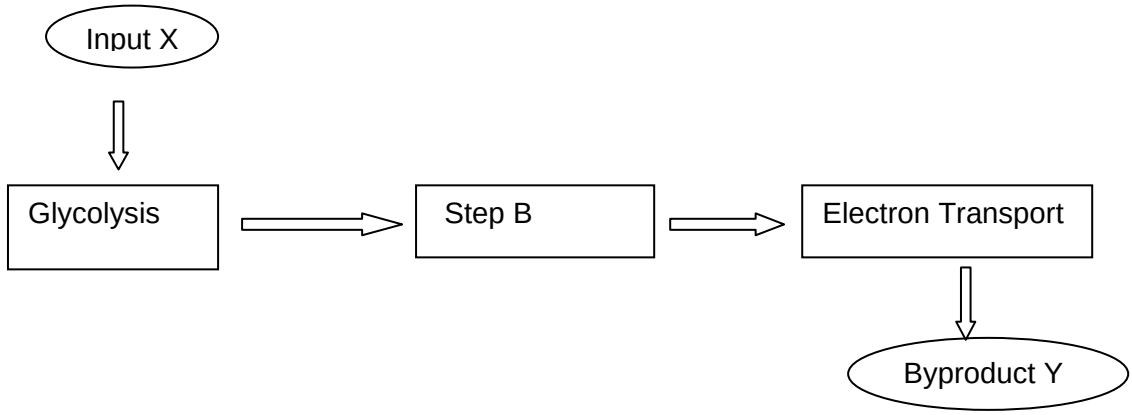
_____

_____

1 mark

Total 6 marks

QUESTION 3
The following diagram shows a simplified representation of a biochemical process.



(a) (i) Name Input X

_____

(ii) Name Byproduct Y

_____

1+1=2 marks

(b) (i) Within a cell, where does Step B occur?

_____

(ii) Describe what happens during Step B.

_____

_____

_____

_____

_____

_____

1+2=3 marks

Total 5 marks

QUESTION 4
In animals, homeostasis is a term used to describe a relatively stable internal environment.

(a) What is the internal environment of the body?

_____

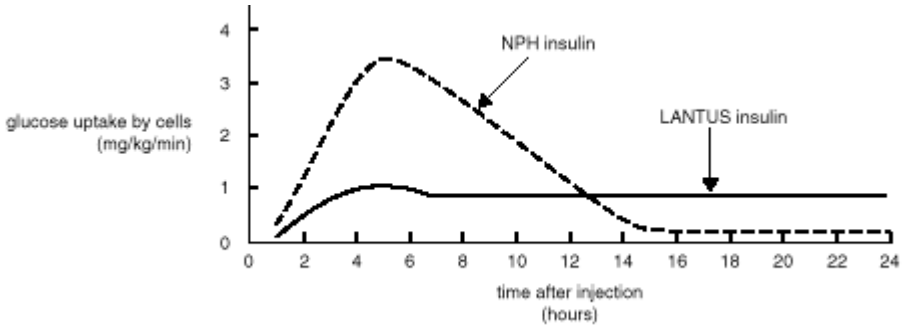
_____

I mark

Type 1 diabetes mellitus is characterised by loss of the insulin-producing beta cells of the islets of Langerhans in the pancreas, leading to insulin deficiency. A common treatment has been NPH insulin but recently the activity of a new type of insulin, called LANTUS insulin, has been tested and compared with NPH insulin.

Participants in the test were divided into two groups. One group received NPH insulin. The second group received LANTUS insulin. All participants received the same amount and concentration of the appropriate insulin.

The following graph shows the average results for participants in each of the two groups.



Insulin is regarded as being effective when the glucose uptake by cells is above 0.4 mg/kg/min.

(b) After the injections, for how long was each kind of insulin effective?

_____

_____

_____

2 marks

(c) Suggest why using LANTUS insulin may be an advantage for a person who has insulin-dependent diabetes.

_____

_____

1 mark

(d) Explain what events may occur to regulate the uptake of glucose in a non diabetic.

_____

_____

_____

_____

_____

2 marks

(e) Some types of diabetes can be further classified as an immune-mediated disorder, where beta cell loss is a T-cell mediated autoimmune attack. Describe what is meant by a T-cell mediated autoimmune disease in relation to diabetes?

_____

_____

_____

_____

_____

2 marks

Total 8 marks

QUESTION 5
The concentration of an unknown protein (X) increased dramatically after depriving a particular plant of water.

(a) Assuming this protein belongs to a class of signalling molecules, identify protein X.

_____

1 mark

(b) Describe the process that would have initiated the production of Protein X under these conditions.

_____

_____

_____

2 marks

In order to accurately identify this protein was isolated from the plant and subjected to proteomic analysis. This involved trypsin digestion followed by mass-spectrometry of the resulting peptides. The results are presented in Table 1 below. Each amino acid has a unique molecular mass and isoelectric point which is affected by pH. The Molecular Weight (daltons) and the isoelectric point (pI) shown in Table 2 is calculated from the primary structure.

Table 1	
Experimental mass of Protein X Peptide	
Mol Wt	842 da

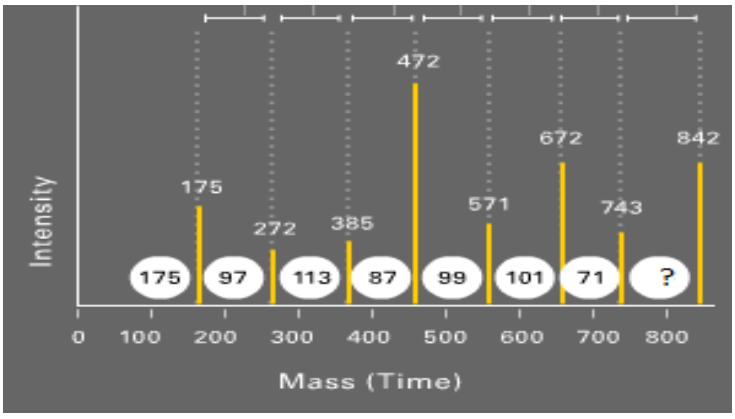


Table 2 **Known Masses and pI of Amino Acids from Protein data bank.**		
Amino Acid	**Molecular Mass (Daltons)**	**Isoelectric Point (pI)**
Aspartate	115	2.77
Glutamate	129	3.22
Histidine	137	7.59
Lysine	120	9.74
Arginine	175	10.76
Alanine	71	6.01
Proline	97	6.48
Leucine	113	5.98
Serine	87	5.68
Threonine	101	5.87
Valine	99	5.97

(c) (i) From the data in Tables 1 and 2 identify the most likely 8 amino acids in sequence for the protein X peptide.

_____

_____

(ii) Briefly justify your answer.

_____

_____

_____

1+1=2 marks

(d) What is the rationale for the identification of unknown proteins using MolWt and pI of amino acids in a peptide?

_____

_____

_____

1 mark

(e) Proteomics has its share of challenges. Why is it more complicated than genomics?

_____

_____

_____

_____

2 marks

Total 8 marks

QUESTION 6
Asprin (salicylic acid) can have the effect of inhibiting enzyme activity. This effect can be investigated using the starchamylase reaction:

Starch —Amylase→ **Simple Sugars**

Iodine *Blue black* → *Iodine Brown*

Where the time taken for the colour change is a measure of enzyme activity.

(a) What is an enzyme inhibitor?

_____

_____

_____

1 mark

(b) Design an experiment to investigate the effect of aspirin on amylase.

_____

_____

_____

_____

_____

_____

_____

_____

3 marks

Total 4 marks

QUESTION 7

(a) Define the term apoptosis.

_____

_____

_____

1 mark

(b) What is the role of phagocytes during apoptosis?

_____

_____

_____

1 mark

(c) Suggest a role for cytokines during apoptosis.

_____

_____

_____

1 mark

(d) How are defects in the regulation of the signalling pathway responsible for apoptosis implicated in the diseases of organisms?

_____

_____

_____

1 mark

Total 4 marks

QUESTION 8
Chronic myeloid leukaemia (CML) is a disorder characterised by the rapid and unregulated growth of cells that originate in the bone marrow such as neutrophils, eosinophils and basophils.

(a) (i) Immature B cells are also formed in the bone marrow. What is the role of these cells in a healthy individual?

_____

_____

_____

(ii) State the specific function of one of neutrophils, eosinophils or basophils.

_____

_____

_____

1+1=2 marks

A new type of drug used to treat CML acts by specifically inhibiting the enzyme tyrosine kinase that is characteristic of a cancer cell, rather than nonspecifically inhibiting and killing all rapidly dividing cells.

(b) Explain how this drug could inhibit tyrosine kinase.

_____

_____

_____

1 mark

(c) Suggest one advantage of this new drug in terms of the nonspecific treatments.

_____

_____

1 mark

(d) Outline the steps a scientist would have to go through to design such a drug.

_____

_____

_____

_____

_____

3 marks

(e) Suggest one improvement that could be made to your drug design to make it more successful in the treatment of CML.

_____

_____

_____

1 mark

Total 8 marks

End of Paper