

**HUMAN BIOLOGY**

**UNITS 2**

**2021**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Teacher: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Time allowed for this paper**

Reading time before commencing work: ten minutes

Working time: two and a half hours

**Materials required/recommended for this paper**

***To be provided by the supervisor***

This Question/Answer booklet

Multiple-choice answer sheet

***To be provided by the candidate***

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: non-programmable calculators approved for use in this examination

**Important note to candidates**

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

|  |  |
| --- | --- |
| **Question** | **Answer** |
| 1 | B |
| 2 | D |
| 3 | A |
| 4 | C |
| 5 | A |
| 6 | A |
| 7 | B |
| 8 | A |
| 9 | B |
| 10 | C |
| 11 | C |
| 12 | C |
| 13 | C |
| 14 | C |
| 15 | B |
| 16 | A |
| 17 | B |
| 18 | B |
| 19 | C |
| 20 | A |
| 21 | D |
| 22 | C |
| 23 | D |
| 24 | B |
| 25 | B |
| 26 | B |
| 27 | C |
| 28 | C |
| 29 | A |
| 30 | B |

**Section Two: Short answer 50% (80 Marks)**

This section has **seven** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 60 minutes.

**Question 31 (12 marks)**

(a) Identify (3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Process A: Transcription | 1 |
| Structure B: mRNA | 1 |
| Process C: Translation | 1 |
| **Total** | **3** |

(b) Explain the role of the nucleus in protein synthesis. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Nucleus controls all cellular activities | 1 |
| Genes make up segments of DNA in a chromosome | 1 |
| Information in a gene is transcribed into mRNA | 1 |
| mRNA in cytoplasm is translated into a protein. | 1 |
| Other roles include:  - ribosomes, used for synthesis, are produced in the nucleus  - nucleus has receptors for inducing protein synthesis |  |
| **Total** | **4** |

Mitosis and meiosis are two types of cell division that share some similarities but they are different in so many ways.

(c) Using a table, compare and contrast the differences between mitosis and meiosis. (6 marks)

|  |  |  |
| --- | --- | --- |
| **Contrasting** | | **Mark** |
| **Mitosis**   * Produces **two** daughter cells. * Takes place **everywhere** in the body. * Produces two **diploid** cells. * Produces **identical** daughter cells. * Requires **one** cell division. * Used for growth and maintenance. * Homologous chromosomes do not pair * No crossing over occurs | **Meiosis**   * Produces **four** daughter cells * Takes place in the **gonads** * Produces four **haploid** cells * Produces **varied** daughter cells * Requires **two** cell divisions * Used for producing gametes/ sexual reproduction. * Homologous chromosomes pair up. * Crossing over occurs | 1-5 |
| **Comparing** | |  |
| They both involve cell division.  They both have common phases: prophase, metaphase, anaphase, telophase.  Synthesis of DNA occurs in both types of cell division.  Any two | | 1-2 |
|  | | **6** |

**Question 32 (12 marks)**

(a) Name the following structures: (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Structure 5: vas deferens | 1 |
| Structure 6: epididymis | 1 |
|  |  |
| **Total** | **2** |

(b) Structures 1 and 2 are known as accessory glands. State the effect that each structure

has on the sperm. (2 marks)

|  |  |
| --- | --- |
| **Description:** | **Mark** |
| Seminal vesicle: provides sperm with sugars for energy | 1-2 |
| Prostate gland: aid in the transport of sperm/ makes semen runnier |
| Both: increase pH of vagina |
| **Total** | **2** |

(c) The first stage of the fertilisation of an oocyte by a single spermatozoan involves the acrosome. Describe the role of the acrosome during the first stage of fertilisation.

(3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| acrosome/sperm comes into contact with zona pellucida | 1 |
| acrosome releases enzymes that break down zona pellucida | 1 |
| sperm nucleus enters oocyte | 1 |
| **Total** | **3** |

In women the menstrual cycle is controlled by hormones secreted from the pituitary gland and the ovary. The chart below lists **some** of the events that occur during the menstrual cycle. They are not in the correct order.

|  |  |
| --- | --- |
| **Stage** | **Event** |
| A | Follicles secrete oestrogen |
| B | This stimulates growth of the endometrium |
| C | FSH secreted by pituitary gland |

(d) List the above mentioned stages in the correct sequence. (3 marks)

|  |  |  |
| --- | --- | --- |
| **C** | **A** | **B** |

(e) Lactational amenorrhoea (LAM) is the temporary infertility that follows the birth of a

child. Describe how LAM can be used as a form of contraception. (2 marks)

|  |  |
| --- | --- |
| **Description: Any two of the following** | **Mark** |
| Frequent breastfeeding/lactating inhibits secretion of gonadotropins (FSH & LH) | 1 |
| Lack of FSH prevents development of follicles / no fertilisation of egg by sperm since no LH is released. | 1 |
| **Total** | **2** |

**Question 33 (16 marks)**

To study the effect of HIV viral load on the average count of leucocytes found within human blood, medical researchers studied six groups of 20 HIV patients in each group, with different viral loads. Number of leucocytes was counted and averaged from each group. The results are shown below.

|  |  |
| --- | --- |
| **Viral load(HIV/mL blood)** | **Average concentration of leucocytes (cells/1µL of blood)** |
| 10000 | 200 |
| 20000 | 150 |
| 40000 | 120 |
| 80000 | 80 |
| 100000 | 50 |
| 120000 | 30 |

(a) Identify the dependent variable in the information shown above. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Dependent : Average concentration of leucocytes | 1 |
| **Total** | **1** |

(b) Propose a hypothesis for this study. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Increasing viral load decreases the count of leucocytes in blood  Both variables mentioned AND relationship described. | 2 |
| **Total** | **2** |

(c) Graph the results from the table above onto the grid provided.(5 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Title (Average concentration **and** viral load mentioned)  Variables on the correct axes  Units next to variables  Correct scale/s  Line graph | 1-5 |
| **Total** | **5** |

(d) Using data from your graph, describe how viral load affects leucocyte concentration in blood. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Direct relationship/ white blood cell count decreases with increasing viral load | 1 |
| Specific data points from graph used to support statement | 1 |
| **Total** | **2** |

(e) Patients infected with HIV, if left untreated, will progress through three stages. Briefly describe each of those stages. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Stage 1   * Acute infection – virus replicated rapidly and flu like symptoms experienced   Stage 2   * Chronic infection – virus replicates more slowly and patient is asymptomatic   Stage 3   * AIDS – immune system is damaged an cannot resist other infections (or low level of T-lymphocytes) | 1-3 |
| **Total** | **3** |

(f) What type of leucocytes are attacked by the HIV virus? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| T-Lymphocytes | 1 |
| **Total** | **1** |

(g) Describe two ways in which HIV can be transmitted. (2 marks)

|  |  |
| --- | --- |
| **Description: Any 2 of the following** | **Mark** |
| * Unprotected sex * Sharing of needles and syringes with an infected person * Infected mother to child during pregnancy, childbirth or breastfeeding * Blood transfusions if bloody not tested carefully * Implements that pierce skin if not sterilised | 1-2 |
| **Total** | **2** |

**Question 34 (11 marks)**

(a) Without representing the exact number of chromosomes in a human cell, draw a labelled, annotated diagram of a cell in anaphase 1 of meiosis

. (7 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| * Labelled chromosome AND centromeres * Labelled spindle AND centrioles * Homologous chromosome pairs moving away from one another. * Centrioles at opposite poles * Spindle fibres attached to centromeres * No nuclear membrane / indication of events in cytosol * Cell membrane present | 1-7 |
| **Total** | **7** |

(b) Describe what happens in the next phase of meiosis (4 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| * Chromosomes gather at each pole * Chromosomes decondense * Nuclear membranes reform (at each pole) * Spindle disappears | 1-4 |
| **Total** | **4** |

**Question 35 (17 marks)**

Blood groups in humans is an example of a phenotype that can be determined by multiple alleles.

(a) Complete the table below showing the possible genotypes for each blood group.

(4 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| A: IAIA and IAi (must have both for mark) | 1 |
| B: IBIB and IBi (must have both for mark) | 1 |
| AB: IAIB | 1 |
| O: ii | 1 |
| **Total** | **4** |

(b) The ABO blood grouping system is an example of codominance. Define this term.

(1 mark)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Two or more alleles are equally dominant/ both alleles expressed in phenotype | 1 |
| **Total** | **1** |

(c)Mrs Smith has Type A blood, but she is not sure if she is homozygous or heterozygous. Mr Smith is completely unsure of his blood type. Their children have the following blood types: Daniel has Type O blood, Michael and Nathan have type A blood, Kyla has type B blood and Oliver has type AB blood.

What are the possible genotypes of both Mr and Mrs Smith? Use a Punnett square to justify your answer.(3 marks)

**Mrs Smith IA i x Mr Smith IB i**

1 mark

1 mark

IA i

|  |  |
| --- | --- |
| IAIB | IBi |
| IAi | ii |

IB

1 mark

i

(d) Haemophilia is a recessive, sex-linked disorder which causes an inability to clot when bleeding.

Roy and Elaine Brown were married in 1986. Neither Roy nor Elaine had haemophilia. They had two daughters and then a son. Both daughters, Alicia and Candace, had normal clotting abilities and never had any children of their own. The son, Mike, had haemophilia and married Beth, who did not have the disease. They had two children of their own, first Ethan and then Ella. Surprisingly, Ella had haemophilia, but Ethan did not.

1. Draw the pedigree, using a legend, that traces the haemophilia disorder in this

family. (4 marks)

**Diagram, schematic

Description automatically generated**

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Use a legend showing condition as recessive if shaded is recessive or dominant | 1 |
| Generations labelled I, II and III | 1 |
| Circles for females and squares for males |  |
| Mike and Ella (shaded) as recessive | 1 |
| **Total** | **4** |

(ii) Write the genotypes for: (3 marks)

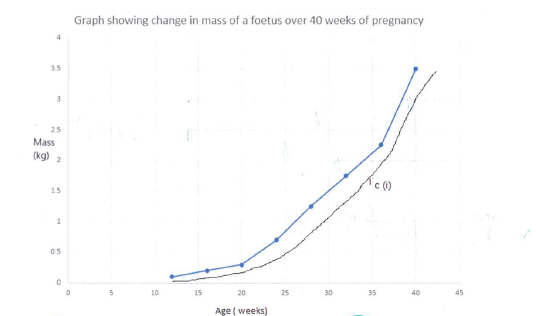
|  |  |
| --- | --- |
| **Description** | **Mark** |
| Elaine - XNXn | 1 |
| Ethan - XNY | 1 |
| Mike - XnY | 1 |
| **Total** | **3** |

(iii) Why are males more commonly affected by X-linked recessive conditions? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Boys only have one x-chromosome, therefore only need to inherit one affected allele to show disease, it can not be masked | 1 |
| Girls have 2 x chromosomes, both need to be affected, more likely to have one affected one masked by a normal one | 1 |
| **Total** | **2** |

**Question 36 (12 marks)**

The graph below shows the change in mass of a foetus over the 40 weeks of a human pregnancy.



(a) Using the graph, determine the age bracket(time frame) when mass changes occur (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| The fastest: 36-40 weeks | 1 |
| The slowest: 12-16 or 12-20 | 1 |
| **Total** | **2** |

(b) State the mass of the foetus at 35 weeks. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| 2.1 – 2.2 kg | 1 |
| **Total** | **1** |

Lifestyle choices of a pregnant mother can impact on the development of a foetus.

(c) (i) Sketch on the graph a line that could indicate the effect on foetal growth if a mother continued to smoke whilst pregnant. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Line should follow original line but be underneath (smoking slows down growth rate) | 1 |
| **Total** | **1** |

(ii) Identify the condition that alcohol may have on the developing foetus

(1 mark)

|  |  |
| --- | --- |
| **Description- Any three of the following** | **Mark** |
| ***Condition***: Foetal alcohol syndrome (FAS)/ Foetal alcohol spectrum disorder (FASD) \*not accepting abbreviation | 1 |
| **Total** | **1** |

(d) (i) Name **one** substance that would be in higher concentration in the umbilical vein than in the umbilical artery. (1 mark)

|  |  |
| --- | --- |
| **Description: Any two of the following** | **Mark** |
| Glucose  Oxygen  Nutrients **Any one** | 1 |
| **Total** | **1** |

(ii) Cavity X contains maternal blood. Suggest why it is advantageous to have this blood in a cavity rather than contained within a blood vessel. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Chorionic villi get bathed/ surrounded by blood | 1 |
| This enhances diffusion/active transport | 1 |
| **Total** | **2** |

(e) The average weight gain of a pregnant mother is 12kg. The average baby, weighs 3.5kg. Name one other change in the mother that contributes to this weight gain. (1 mark)

|  |  |
| --- | --- |
| **Description: Any one of the following** | **Mark** |
| * Increased blood volume * Placenta * Amniotic fluid * Increased breast size * Increased uterus size * Hormonal changes promote the conversion of energy to fat * Water retention | 1 |
| **Total** | **1** |

(f) For each of the stages of labour, identify the major change that occurs. (3 marks)

|  |  |
| --- | --- |
| Stage of labour | Major change occurring |
| 1st stage | * Dilation of cervix * Waves of contractions |
| 2nd stage | * Baby is expelled |
| 3rd stage | * Placenta, membranes and umbilical cord (afterbirth) expelled |

**End of Section Two**

**Section Three: Extended answer 20% (40 Marks)**

**Unit 1**

**Question 39 (20 marks)**

(a) Name **two** causes of male and **two** causes of female infertility and explain **two** ways in which infertility can be treated. Include in your explanation the name of the treatment, how the treatment is carried out and any disadvantages that might be associated with the treatment. (12 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| **Female infertility: any two of the following**   * Age (over 36) * Polycystic ovarian syndrome * High levels of prolactin * Cancer treatments * Endometriosis * Fibroids * Uterine tube blockages * Hormonal imbalances * Untreated STI’s – only if specified complications, could not just say ‘chlamydia’ * NOT sterilisation * ‘ovulation problems – needed to be specified | 1-2 |
| **Male infertility: any two of the following**   * Low numbers of sperm * Low motility of sperm * Abnormal sperm * Blockage of vas deferens * Hormonal imbalances * Untreated STI’s – only if specified complications, could not just say ‘chlamydia’ * NOT sterilisation | 1-2 |
| **Treatment of infertility: Any two of the following** |  |
| 1. IVF- In vitro fertilisation | 1 |
| * Hormonal treatment used to stimulate woman’s ovaries to produce multiple follicles * Egg and sperm are collected and egg is fertilised in a lab. * An embryo is then inserted into the uterus via a catheter | 1-2 |
| Disadvantages (any of the following)   * Multiple pregnancies * Surgery risk when harvesting eggs * Miscarriages are common * Hormone treatment is unpleasant and has side effects | 1 |
| 2.GIFT- gamete intrafallopian transfer | 1 |
| * Female ovaries stimulated to produce more than one egg * Sperm and egg are collected and mixed together in a lab * then injected into the fallopian tubes. | 1-2 |
| Disadvantages (any of the following)   * Surgery risk when harvesting eggs/ injecting gamete into fallopian tube * Lower pregnancy rate * Hormone treatment is unpleasant and has side effects | 1 |
| 3.ICSI**-** Intracytoplasmic sperm injection | 1 |
| * Eggs collected and examined for suitability * Sperm injected into cytoplasm of the egg * Resulting cells monitored to ensure they develop normally before being placed into uterus | 1-2 |
| Disadvantage   * genetic defects could be passed on to offspring | 1 |
| 4.AI- artificial insemination | 1 |
| * Sperm collected from partner or donor male * Sperm is processed and concentrated * Sperm is released into the uterus using a catheter | 1-2 |
| Disadvantage   * Success rate is low per cycle * May be hard to find a suitable donor | 1 |
| **Accept any other reasonable answers Total** | **12** |

All abbreviations needed to be explained eg GIFT needed to be Gamete intra fallopian transfer.

Needed to be smart about explaining the treatment. Saying using drugs for ED was not enough scope to give all the marks available!

Surgery was allowed as an option.

Surrogacy is not treating a person with infertility, it is giving them an alternate way of having a child. Therefore NOT allowed.

(b) Define the term epigenetics and explain how chromatin modification can affect gene expression. (8 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| * Inherited phenotype changes/ changes to gene expression * That do not involve alterations to base sequence | 1-2 |
| **Chromatin modification**  **Acetylation- any three of the following**   * Addition of an acetyl group to the histone protein * Relaxes structure of chromatin OR * Promotes transcription by allowing RNA polymerase access * Enhances gene expression   **DNA Methylation- any three of the following**   * Methyl groups added to DNA * At CpG sites/where a cytosine nucleotide is adjacent to a guanine * Tightens chromatin * Inhibits gene expression * Restricts access of RNA polymerase | 1-3  1-3 |
| **Total** | **8** |

**Question 40 (20 marks)**

(a) A pregnant woman has a family history of a rare recessive disease. She was advised

to undergo foetal genetic analysis. She was given the choice between amniocentesis

and chorionic villus sampling. She studied both methods and decided on one method.

Outline three features of each method, and, justify her choice. In your answer include

the timeframe when each one is carried out and the advantages and disadvantages of

each method. (8 marks)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Amniocentesis** | **Chorionic villus sampling** | **Mark** |
| **Feature**  any 3 | - an ultrasound is used to guide a needle through the abdominal wall into the amniotic cavity.  - a sample of amniotic fluid is removed which contains foetal cells. | - an ultrasound is used to guide a needle through the abdominal wall into the chorion.  - a sample of chorion is removed which contains foetal cells. | Two per process  (1 – 4) |
| **Advantages** | * Can diagnose spina bifida * Can diagnose a wide range of genetic disorders | * Can conduct test sooner than amniocentesis (9 weeks) * Foetal tissue can be tested more quickly | One per process  (1-2) |
| **Disadvantages** | * Must wait until 16 weeks to perform test * Risk of infection/miscarriage/damage to the baby | * Can’t diagnose spina bifida * Risk of miscarriage | One per process  (1-2) |
|  | **Total** | | **8** |

(b) (i) Explain how gel electrophoresis is used to produce a DNA fingerprint. (6 marks)

|  |  |
| --- | --- |
| **Description: Any six of the following points** | **Mark** |
| * DNA samples are placed in wells in a semi-solid gel * electrodes are located at each end * Wells are located at the end with the negative electrode * DNA is negatively charged * An electrical current is passed through the gel * the DNA moves towards the positive electrode * Smaller fragments of DNA move through the gel **faster** and therefore travel **further** (or a contrasting description about larger fragments) * Banding pattern is formed | 1-8 |
| **Total** | **8** |

(ii) Describe how the DNA profile can be used to determine parentage. (4 marks)

|  |  |
| --- | --- |
| **Description- Any four of the following** | **Mark** |
| * DNA profile compared for parents and child * child’s DNA profile should possess a combination of parental fragments * all fragments produced in the child’s profile should also be produced by either mother or father * a man can be excluded as a parent of a child if he does not match with the child on at least 2 loci | 1-4 |
| **Total** | **4** |

**Question 41 (20 marks)**

1. Describe the steps in the DNA replication within a cell. (8 marks)

|  |  |
| --- | --- |
| **Description: Any eight of the following points** | **Mark** |
| * DNA replication occurs in interphase (S phase) * DNA strands separate due to breaking of hydrogen bonds (due to helicase) * RNA primers attach to each DNA strand (due to primase) * DNA polymerase attaches and adds nucleotides 5’ to 3’ direction * Nucleotides added are complementary to those on the original strand * Leading strand forms continuously * Lagging strand forms in sections * RNA primers removed and DNA nucleotides fill the spaces * Ligase joins up the fragments | 1-8 |
| **Total** | **8** |

1. Describe in detail two (2) ways that variation can be created through the process of meiosis.
2. (6 marks)

|  |  |
| --- | --- |
| **Description – marks from any 2 sections only**  **1 mark per point** | **Mark** |
| Random Assortment (independent Assortment   * In first meiotic division, homologous chromosomes line up together * Each homologous pair separate and head to opposite centrioles * Each pair does that independently of the others * With 23 pairs of chromosomes, possible combos = 223 | 1-3 |
| Crossing Over   * In first meiotic division homologous chromosomes line up together * Non-sister chromatids exchange material * Form recombinant chromosomes * New chromosome is not the same as wither that came from the parent | 1-3 |
| Non Disjunction   * Can occur in either meiotic division * Failure of chromosomes (or pairs) to separate in Anaphase * Results in daughter cells that have either one more or one less chromosome than it should do. * Can result in trisomy / monosomy AFTER fertilisation | 1-3 |
| **Total** | **6** |

(c) Stem cells can be classified according to where they originate or the types of cells that they can differentiate into. Identify and describe three different potencies of stem cells, and provide an example of each. (6 marks)

|  |  |
| --- | --- |
| **Description – marks from any 3 sections only**  **1 mark per point** | **Mark** |
| Totipotent   * Stem cell that can differentiate into any other cell type, including embryonic / foetal membranes * Zygote ( or other stage up to and including morula) | 1-2 |
| Pluripotent   * Stem cell that can differentiate into a wide variety, but not all other cell types (fewer than totipotent) * Induced pluripotent stem cells, embryonic stem cells (Blastocyst through to endo / ecto / mesoderm stage) | 1-2 |
| Multipotent   * Stem cell that can differentiate into a small number of related cell types (fewer that pluripotent * Haemopoietic stem cells (make blood cells) | 1-2 |
| Unipotent   * Stem cell that can only renew itself and differentiate into one cell type * Spermatogonia or oogonia | 1-2 |
| **Total** | **6** |

**End of questions**