PART A: MULTIPLE CHOICE SECTION
Please circle the most appropriate response on the answer sheet provided.
(20 questions - 20 marks)

1. Which nitrogenous base is not found in DNA?
   A) Adenine
   B) Thymine
   C) Cytosine
   D) Uracil

2. In the following pedigree the shaded individual has the trait under investigation.

   The mode of inheritance of the trait is
   A) autosomal dominant
   B) codominant
   C) X-linked dominant
   D) autosomal recessive

3. The following nucleotide sequence forms part of the template strand of a gene coding for protein X.
   T G G A T G A C
   The complementary base to the fourth base (marked in bold) formed during DNA replication:
   A) A
   B) C
   C) T
   D) G

4. The edible pea (Pisum sativum) has a diploid number of 14. Specific cells in the ovary undergo meiosis to produce gametes. The number of DNA molecules in one of these cells at the beginning of meiosis would be:
   A) 28
   B) 7
   C) 21
   D) 14
5. In a particular breed of cats, a gene influencing coat colour has three alleles. They are:

- \( B \) = black coat
- \( b^R \) = brown coat
- \( b \) = white coat

Black coat is dominant to both brown and white coat. A cat with the genotype \( b^R \ b \) results in another intermediate coat colour known as fawn.

It is reasonable to predict that the cross

A) \( B \ b^R \times B \ b^R \) would result in all black cats
B) \( b^R \ b^R \times b^R \ b \) would result in all brown cats
C) \( b^R \ b^R \times b \ b \) would result in all fawn cats
D) \( B \ b \times b \ b \) would result in all white cats

6. Alternative forms of genes for a particular characteristic are called

A) homologous chromosomes
B) alleles
C) genotypes
D) phenotypes.

7. Which of the following is not a function of mitosis in animals?

A) asexual reproduction
B) growth
C) repair of damaged organs
D) production of gametes

8. Which of the following statements about homologous chromosomes is correct?

A) Each gene is at the same locus on both chromosomes.
B) They are two identical copies of a parent chromosome which are attached to one another at the centromere.
C) They always produce identical phenotypes.
D) They are chromosomes that have identical genes and alleles.

9. The position on a chromosome where a particular DNA sequence is located is called

A) the gene
B) the locus
C) the chromatid
D) the allele
10. The backbone of the DNA molecule is made up of
   A) phosphate molecules and ribose sugars
   B) deoxyribophosphate molecules and ribose sugars
   C) phosphate molecules and deoxyribose sugars
   D) deoxyphosphate molecules and deoxyribose sugars

11. Albinism is a recessive condition found in humans, that causes a lack of pigmentation. Two normally pigmented parents are heterozygous for albinism. The probability that they have an albino child would be:
   A) 1/4
   B) 1/16
   C) 1/2
   D) 0

12. Which of the following correctly represents the genotype of an individual who is homozygous recessive for an autosomal disorder?
   A) Hh
   B) XhY
   C) XhXh
   D) hh

13. The pedigree below shows which members of a family were Rhesus positive (■ and ●) and Rhesus negative (□ and ○). The allele for Rhesus positive blood (Rh+) is dominant over the allele for Rhesus negative blood (Rh−).

   ![](pedigree.png)

Which are possible genotypes of the individuals numbered I, II and III?

- A) Rh+ Rh+ Rh+ Rh+ Rh+ Rh−
- B) Rh+ Rh+ Rh+ Rh− Rh+ Rh+
- C) Rh+ Rh+ Rh+ Rh− Rh+ Rh−
- D) Rh+ Rh− Rh+ Rh− Rh+ Rh+
14. What does the karyotype below correspond to?

A) A normal male
B) A normal female
C) A female with Down syndrome
D) A male with Down syndrome

15. Which process tends to reduce variety within a population?
   A) Natural selection
   B) Random fertilization
   C) Artificial breeding
   D) Crossing over

16. Which of the following will promote variation in a species?
   
   I. Meiosis
   II. Fertilization
   III. Natural selection

   A) I only
   B) II only
   C) I and II only
   D) I, II and III

17. Which of the following is the correct definition of evolution?

   A) A change in the heritable characteristics of a population
   B) An increase in the mutation rate of a population
   C) A high level of selection pressure on a population
   D) The selection of a specific desirable characteristic in an individual
18. Which of the following represent homologous features?
   A) Wings in birds and insects
   B) The appendix in humans and horses
   C) Fins in fish and wings in birds
   D) The striped coat of the zebra and the tiger

19. Why has antibiotic resistance evolved in bacteria?
   A) All bacteria reproduce very quickly.
   B) Bacteria exposed to antibiotics developed a resistance to them.
   C) Varieties of bacteria resistant to antibiotics reproduce faster than non-resistant varieties.
   D) Bacteria showing resistance to antibiotics survive after antibiotics are used.

20. Charles Darwin used domesticated animals to provide evidence for evolution by natural selection. What is this evidence?
   A) Differences between breeds show that selection can cause species to change.
   B) The ancestors of domesticated animals can be found in the fossil record.
   C) Some domesticated animals die because the environment cannot support them all.
   D) Variation in domesticated animals is due to sexual reproduction.
1. Explain, using an example, how chromosome number can increase in human beings.

   Error occurs during meiosis;
   (homologous) chromosomes fail to separate resulting in some gametes containing
   an extra chromosome;
   eg. gametes that contain extra copies of chromosome 21 resulting in Down
   Syndrome in Trisomy 21 in the zygote

   (Total 3 marks)

2. The pedigree diagram below shows the inheritance of a trait in a particular family. Examine it carefully and answer the questions that follow.

   ![Pedigree Diagram]

   (a) In relation to the pedigree diagram what do the Roman numerals represent? 1 mark

   **Generation number**

   (b) What is the gender of person II 3? 1 mark

   **Male**
(c) Explain, using the evidence from the pedigree, whether the inheritance shown is autosomal dominant, autosomal recessive, sex-linked dominant or sex-linked recessive. (Your answer needs to include the reason/s why the other forms of inheritance are not possible).

- **Autosomal dominant;**
  - Trait appears in all generations / heterozygotes able to hide recessive allele and still pass have unaffected children;
  - Can’t be autosomal recessive b/c of Individual III-6 (unable to obtain dominant allele from parents to hide trait)
  - Can’t be sex-linked b/c no male:female gender bias exists
  - Can’t be X-linked dominant b/c of Individual III-6 (unable to obtain second recessive allele from parents)
  - Can’t be X-linked recessive b/c of Individual III-6 (unable to obtain dominant allele from parents to hide trait)

(d) Assign and define appropriate allele symbols for the condition.

- Affected – H
- Unaffected - h

(e) Using the allele symbols you chose above, describe carefully the chances of individuals I 1 and I 2 having a girl with the trait.

Mark 1 → I-1 = Aa and II-2 = aa

Mark 2 → working

  F1 genotype ratio: 50% Aa : 50% aa
  F1 phenotype ratio: 50% affected : 50% unaffected

Mark 3 → Therefore they would have a 50% chance of having a girl with the trait

(Total 10 marks)
3. Explain the differences between meiosis and mitosis.
   
   **Paired statements must be used in order to receive full marks for these questions.**

<table>
<thead>
<tr>
<th>MEIOSIS</th>
<th>MITOSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 daughter cells produced</td>
<td>2 daughter cells produced</td>
</tr>
<tr>
<td>Daughter cells non-identical to parent cell</td>
<td>Daughter cells identical to parent cell</td>
</tr>
<tr>
<td>Daughter cells contain 23 chromosomes (1 set of chromosomes)</td>
<td>Daughter cells contain 46 chromosomes (2 sets of chromosomes)</td>
</tr>
<tr>
<td>Daughter cells contain only one sex chromosome: either X or Y</td>
<td>Daughter cells contain two sex chromosomes: XX or XY</td>
</tr>
</tbody>
</table>

(Total 3 marks)

4. Red hair is an **autosomal recessive** trait.

   Using a punnet square, determine the chance of a mother (who is heterozygous for non-red hair) and a father (who has red hair) having a child with non-red hair.

   **Mark 1** ➔ identify parental genotypes (*including* key – H = non-red; h = red)

   Hh  and II-2 = hh

   **Mark 2** ➔ working

   F1 genotype ratio: 50% Hh : 50% hh

   F1 phenotype ratio: 50% non-red hair : 50% red hair

   **Mark 3** ➔ answer

   Therefore they would have a 50% chance of having child without red hair

(Total 3 marks)
5. Can a father with blood type B and a mother with blood type A have a child with blood type O? Explain.

Mark 1 → answer = Yes
Mark 2 → explanation using working out

If dad is I^B_i (B) and mum is I^A_i (A), there is a 25% of having an i (O) child

(Total 2 marks)

6. Duchenne muscular dystrophy (DMD) is a recessive X-linked form of muscular dystrophy, which results in muscle degeneration and eventual death.

(a) What is meant by sex-linked inheritance. 1 mark
   Genes are found on the sex chromosomes / X / Y chromosome

(b) If a carrier female of DMD has a child with a normal male, determine the possible genotypes and phenotypes of their offspring. 4 marks

Mark 1 → key
  XD = normal; Xd = DMD
Mark 1 → identify parental genotypes
   X^dX^d and X^DY
Mark 3 + 4 → answers
   F1 genotype ratio: 25% X^D X^D : 25% X^D Y : 25% X^d X^d : 25% X^d Y
   F1 phenotype ratio: 75% normal : 25% DMD

(Total 5 marks)
7. What is the difference between homologous structures and analogous structures?

<table>
<thead>
<tr>
<th>Homologous structures</th>
<th>Analogous structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result of divergent evolution</td>
<td>Result of convergent evolution</td>
</tr>
<tr>
<td>Due to recent common ancestor</td>
<td>Due to different ancestor</td>
</tr>
<tr>
<td>Due to different selection pressures</td>
<td>Due to similar selection pressures</td>
</tr>
<tr>
<td>Similarities in bone structure</td>
<td>Differences in bone structure</td>
</tr>
<tr>
<td>Differences in function</td>
<td>Similarities in function</td>
</tr>
<tr>
<td>Species are closely related</td>
<td>Species are unrelated</td>
</tr>
<tr>
<td>eg. pentadactyl limb structure in vertebrates</td>
<td>eg. wings in insects, birds and bats</td>
</tr>
<tr>
<td></td>
<td>eg. streamlined bodies of sharks and dolphins</td>
</tr>
</tbody>
</table>

(Total 4 marks)

8. Explain how natural selection leads to evolution.

parents produce more offspring than required to keep numbers constant; 
more are produced than the environment can support; 
example of an environmental condition; 
these offspring show variation; 
some are better adapted than others to the environment; 
these tend to survive to breed themselves; 
characteristics are inheritable; 
so the new generation has these characters too; 
this leads to changes in the population as a whole; 
these changes constitute evolution;

(Total 6 marks)