Q 1

List the 4 types of nucleic acids and describe their function.

Q 2

List 3 differences between RNA and DNA.

Q 3

What are 4 sources of genetic variability?

Q 4

What are the difference between germ cell mutations and somatic cell mutations?

Q 5

What are the differences between a gene mutation and a chromosomal mutation?

Q 6

What are causes of mutations?

A 1

- DNA : stores genetic information
- mRNA: carries a copy of the DNA code to the ribosomes during protein synthesis
- tRNA: carries a particular amino acid to the correct mRNA codon site for translation
- rRNA: are building blocks to form a ribosome

A 2

1. RNA is single stranded/DNA double
2. RNA -the base uracil replaces thymine
3. RNA has a ribose sugar instead of deoxyribose

A 3

1. mutations
2. random fertilization of eggs by sperm
3. crossing over of homologous chromosomes in meiosis results in genetic recombinations
4. independent assortment of chromosomes in meiosis, metaphase I results in a large number of possible arrangements

A4

- Somatic cell mutations occur in body cells.
  - these mutations are not passed on to the next generation
- Germ line mutations occur in gamete cells (egg or sperm cells)
  - these mutations are passed on to the next generation

A 5

1. **Gene mutations:** a change in one or a few nucleotides (point mutations)
   - Insertion
   - Deletion
   - Substitution
2. **Chromosomal mutations:** rearrangement of several genes (pieces of chromosomes), including genes located on different chromosomes

A 6

1. Spontaneous: take place naturally within the cell by incorrect base pairing during DNA replication

2. Induced: caused by agents outside the cell such as:

- carcinogens
- UV radiation
- X ray radiation

Q 7 Recite the following transcription steps in the correct sequence:

- When the RNA polymerase reaches a termination sequence both the enzyme and the newly formed mRNA detach
- RNA polymerase binds at the promoter region, a specific nucleotide sequence, of the DNA molecule
- RNA polymerase opens up a section of the double helix
- The DNA double helix reforms
- RNA polymerase attaches complementary mRNA nucleotides to the DNA template to from a single strand of mRNA, replacing the base uracil with thymine as it does so.

Q 8 Recite the following replication steps in the correct sequence:

- DNA ligase joins the fragments
- DNA polymerase III adds complementary nucleotides to the growing strands, adenine pairs with thymine and cytosine pairs with guanine, using the exposed strands of the parent DNA molecule as a template
- DNA polymerase I cuts out the RNA primers and replaces them with the appropriate DNA nucleotides.
- DNA helicase unzips the double helix by breaking the hydrogen bonds between the complimentary bases in the two strands
- The leading strand is formed continuously. The lagging strand is formed in short fragments, Okazaki fragments, starting from an RNA primer.

Q 9 Recite the following transcription steps in the correct sequence:

- The anticodon triplet of a tRNA molecule binds to a complementary codon of the mRNA.
- Each tRNA, carrying its corresponding amino acid, move to the mRNA on the ribosome
- The mRNA moves from the nucleus into the cytoplasm of the cell where it attaches to a ribosome
- The tRNA detaches and the
- process is repeated to build a polypeptide chain Amino acids in the cytoplasm attach to specific tRNA molecules
- A peptide bond joins the amino acid carried by the first tRNA to the amino acid carried by the second tRNA.

Q 10

Which of the following terms apply to the process of **replication?**

- helicase
- RNA polymerase
- codon
- DNA polymerase
- anticodon
- nucleus
- complementary base pairing
- tRNA
- mRNA
- cytoplasm

Q 11

Which of the following terms apply to the process of **transcription?**

- helicase
- RNA polymerase
- codon
- DNA polymerase
- anticodon
- nucleus
- complementary base pairing
- rRNA
- mRNA
- cytoplasm

Q 12

Which of the following terms apply to the process of **translation**?

- helicase
- RNA polymerase
- codon
- DNA polymerase
- anticodon
- nucleus
- complementary base pairing
- rRNA
- mRNA
- dytoplasm

A 8 (Helpful Hint: draw while you explain or use your hands while you explain)

1. DNA helicase unzips the double helix by breaking the hydrogen bonds between the complimentary bases in the two strands
2. DNA polymerase III adds complementary nucleotides to the growing strands, adenine pairs with thymine and cytosine pairs with guanine, using the exposed strands of the parent DNA molecule as a template
3. The leading strand is formed continuously. The lagging strand is formed in short fragments, Okazaki fragments, starting from an RNA primer.
4. DNA polymerase I cuts out the RNA primers and replaces them with the appropriate DNA nucleotides.
5. DNA ligase joins the fragments

A 7 (Helpful Hint: draw while you explain or use your hands while you explain)

1. RNA polymerase binds at the promoter region, a specific nucleotide sequence, of the DNA molecule
2. RNA polymerase opens up a section of the double helix
3. RNA polymerase attaches complementary mRNA nucleotides to the DNA template to from a single strand of mRNA, replacing the base uracil with thymine as it does so.
4. When the RNA polymerase reaches a termination sequence both the enzyme and the newly formed mRNA detach
5. The DNA double helix reforms

A 10

Replication includes:

- the enzyme helicase
- the enzyme DNA polymerase
- complementary base pairing
- occurs in the nucleus

A 9 (Helpful Hint: draw while you explain or use your hands while you explain)

1. The mRNA moves from the nucleus into the cytoplasm of the cell where it attaches to a ribosome.
2. Amino acids in the cytoplasm attach to specific tRNA molecules
3. Each tRNA, carrying its corresponding amino acid, move to the mRNA on the ribosome.
4. The anticodon triplet of a tRNA molecule binds to a complementary codon of the mRNA.
5. A peptide bond joins the amino acid carried by the first tRNA to the amino acid carried by the second tRNA.
6. The tRNA detaches and the process is repeated to build a polypeptide chain

A 12

Transcription includes:

- anticodon: 3 nucleotides thatis complementary to the mRNA codon
- codon
- complementary base pairing
- mRNA
- rRNA: ribosomal RNA is the site where tRNA molecules link each
- mRNA codon to its specific amino acid .
- cytoplasm: site of translation

A 11

Transcription includes:

- the enzyme RNA polymerase
- codons : a set of three bases
- mRNA: a linear single strand of ribonucleotides
- nucleus: process takes place here
- complementry base pairing

Q 13

A mutation is a DNA error that is not repaired.

There are three possible small changes in the DNA's nucleotide sequence that can occur which would lead to a point mutation.

List them.

Q 14

a) What is gene expression?

b) List the two stages of gene expression and the nucleic acids that are used in each stage.

Q 15

Describe a DNA nucleotide.

Q 16

a) Besides nuclear DNA, list two other types of DNA.
b) Why do you only inherit this DNA from your mother and not your father?

Q 17

Define:

1. replicaton
2. translation
3. transcription

Q 18

DNA replication is semi-conservative.
Explain what this means.

A 14

a) Gene expression is a process that allows for the flow of genetic information from DNA to RNA to protein.

b)

- Transcription: uses DNA, mRNA
- Translation: uses mRNA, rRNA (the ribosome) and tRNA

A 13

- **Insertion:** adding nucleotide
- **Deletion:** deleting a nucleotide
- **Substitution:** using an incorrect nucleotide

A 16

a) in mitochondria of animal cells (mtDNA) and in chloroplasts of plant cells

b) The cytoplasm of a zygote is from the ovum; the sperm cell contributes essentially no cytoplasm therefore no organelles

A 15

A DNA nucleotide consists of :

- phosphate
- deoxyribose
- nitrogenous base such as adenine, cytosine, guanine or thymine.

A 18

Replication is semi-conservative: each new DNA molecule contains one strand of the original complementary DNA molecule and one new parent strand

A 17

- **Replication** is the process of making an exact copy of a molecule DNA
- **Transcription** is the process in which the information in a segment of DNA is copied into mRNA.
- **Translation** is the process of protein production using mRNA as a guide.

Q 19

Distinguish between DNA and mRNA in the following:

- Which molecule is transcribed and which molecule is translated?

Q 20

Distinguish between RNA and polypetides in the following:

- Which molecule is produced by transcription and which molecule is produced by translation?

Q 21

Of the two processes, translation and transcription, which process requires a ribosome and which process requires RNA polymerase?

Q 22

What is the difference between a gene and a genome?

Q 23

a) Identify the name of the following genetic engineering tool:

- An enzyme that recognizes a specific DNA sequence and chemically cuts the DNA at that sequence

b) Identify the name of the following genetic engineering tool:

- An enzyme that can rejoin a broken bond in DNA.

Q 24

A pregnant mother would like to use prenatal screening to determine if her fetus has a gene mutation due to a deletion of two nucleotides.

a) Identify and **describe** three technologies that could be used to collect a sample for screening

b) Identify and **describe** a technology used to confirm this mutation in her fetus.

A 20

RNA is produced by transcription and a polypeptide is produced by translation.

A 19

DNA is transcribed and mRNA is translated.

A 22

A gene is defined as a functional sub-unit of DNA that directs the production of one or more polypeptides (protein molecules).

The genome of an organism is the sum of all of the DNA that is carried in each cell of the organism.

A 21

Transcription is done by RNA polymerase; translation is done by ribosomes

A 24

a) 1. Ultrasound: Sound waves are bounced off soft tissue and the echoes produce an image of a fetus displayed on a screen. This screen image is helpful to locate the position of the fetus when withdrawing a tissue sample.
2. Amniocentesis: Withdrawal of amniotic fluid and fetal cells to analyze
3. CVS: Withdrawal and analysis of chorionic villi tissue

b) Gel electrophoresis: used to examine the deleted nucleotide sequence in the fetal DNA by separating fragments of DNA according to their mass and charge

A 23

a) Restriction enzyme.

b) Ligase.

Q 25

What is the genetic code?

Q 26

a) Why is DNA used to study species diversity and evolution?
b) Why do scientists prefer to use mtDNA and not nuclear DNA to study species diversity?

Q 27

Define a transgenic organism

Q 28

a) Define PCR.

b) Provide two examples where PCR would be useful.

Q 29

Explain why a karyotype can't be used to identify a gene mutation.

Q 30

a) Describe gel electrophoresis

b) What is this technology used for?

A 26

a) DNA allows scientists to study genetic variations among individuals of the same species, as well as the genetic variation among different species. This helps scientists to track evolution of a species through time.

b) The structure of and function of nuclear DNA is conserved across all species however mtDNA shows greater variation in the genetic code.

A 25

Genetic code: the order of the base pairs in a DNA molecule of an organism.

A 28

a) PCR is a technique for amplifying a DNA sequence by repeated cycles of strand separation and replication

b) Used for any variety of tasks that require increasing the amount of DNA from an original small sample, such as DNA samples from a crime scene or DNA samples from ancient species

A 27

A transgenic organism is one that contains recombinant DNA: an organism whose genetic material includes DNA from a different species

A 30

a) Gel electrophoresis: DNA fragments, or proteins, are applied to one end of a gel. An electric current is passed through the gel. The rate of migration through the gel depends upon the size and electrical charge of the molecule.

b) The patterns (DNA fingerprint) observed are used to determine the presence or absence of particular DNA segments (or proteins)

A 29

A karyotype identifies chromosome mutations: changes in chromosome number or structure; any changes involving a smaller section of the chromosome, such as a gene mutation, are not physically visible with a karyotype.

Q 31

Identify and describe two technologies that would be used in gene therapy.

Q 32

A pregnant mother would like to use prenatal screening to determine if her fetus has a chromosomal abnormality, such as an extra chromosome on pair 21.

Identify and describe a technolgy that would be used to confirm a chromosome mutation, such as changes in chromosome number in a fetus.

Q 33

Define DNA probe

Q 34

Genetic engineering is used to produce bacterial cells capable of synthesizing human growth hormone.

a) Identify and describe three technologies that would be involved with this process.

Q 35

List and describe three examples where transgenic organisms are used to benefit society.

Q 36

List and describe three societal issues related to the use of transgenic organisms

A 32

1. Karyotype:
2. Cell division is stimulated
3. Cell division is stopped at mitotic metaphase
4. Chromosomes are stained & photographed
5. Homologous chromosomes are paired & numbered.

A 31

Technology #1
restriction enzyme: used to cut out disease causing portion of viral vector

Technology #2
ligase: used to splice in working human gene into the viral genome

A 34

Technology #1
DNA probe: a radioactively labeled nucleic acid molecule used to find the hGH gene in a human cell
Technology #2
Restriction enzyme: cleaves the nucleotide sequence of both bacterial plasmid DNA and human DNA at the specific recognition site
Technology #3
Ligase : splices together the human DNA into the genome of the bacterial plasmid

A 33

- A DNA probe consists of a molecule of radioactively labeled DNA with a nucleic acid sequence that is complementary to a gene of interest.
- The probe will bind to the sequence in the gene of interest.

A 36

1. Enivornmental threat: there is evidence that engineered genes can be transferred to wild plants, raising concerns about the emergence of "superweeds"

2. Health effects: Many consumer groups argue that not enough is known about the long-term effects of consuming transgenic products

3. Social and economic issues: Advocates of genetically modified foods argue that these foods will help to improve human health and alleviate world hunger. Their opponents argue that genetic research absorbs millions of dollars, which would be better spent directly helping people in need.

A 35

1. Transgenic bacteria are making pure human insulin, making medicines at lower costs
2. Transgenic plants, such as golden rice, provide higher nutritional value to feed those who are starving.
3. Transgenic animals, such as goats, are genetically modified to secrete a human polypeptide or other substances in their milk.