1. I can tell the difference between mRNA, tRNA, and rRNA.

Types of RNA: The three main types of RNA are messenger RNA, ribosomal RNA, and transfer RNA. Ribosomal RNA is combined with proteins to form ribosomes.

**Messenger RNA (mRNA)** acts as a copy of the instructions for making a protein. mRNA carries these instructions from inside the nucleus, through the pores of the nuclear envelope, to the ribosomes.

**Transfer RNA (tRNA)** decodes the instructions for building the protein and delivers the amino acids to the ribosome in the correct sequence. The single strand folds in on itself in the shape of a cross. There are 3 nucleotides called an anticodon on the end that translates the mRNA; these are complementary to the codons on the mRNA. A specific amino acid is attached on the other end and is delivered to the ribosome when the tRNA’s anticodon matches the mRNA’s codon.

**Ribosomal RNA (rRNA)** is responsible for bonding the amino acids together to build the protein. Ribosomes are made of rRNA.
2. **I can describe what happens during transcription.**

   During Transcription, a complementary strand of RNA is built from the DNA. This occurs in the Nucleus. DNA must stay in the nucleus, but the instructions for making the protein need to leave the nucleus to go to the ribosomes. RNA polymerase is the enzyme responsible for transcription. It then unwinds and separates the DNA and then adds complementary RNA nucleotides using the DNA as a pattern. Once the gene is fully transcribed into RNA, the mRNA is edited.

3. **I can describe what happens during translation.**

   Two major steps occur during translation: decoding the mRNA and building the protein. Translation occurs in the cytoplasm at the ribosomes. The mRNA is threaded between the two subunits of the ribosome. The mRNA is read in Codons, which are 3 base sequences that code for a specific amino acid. The tRNA molecules have Anticodons that are used to decode the mRNA into the correct sequence of amino acids. The Anticodon is complementary to the Codon (A → U, G → C). When the Anticodon and Codon match correctly, the amino acid attached to the tRNA is delivered to the ribosome. The ribosomal RNA then forms a peptide bond between the new amino acid and the polypeptide (protein) chain that is being produced. This forms the primary structure of the protein. Correct folding, coiling, and combining multiple polypeptide units must occur to form a fully functional protein.
4. I can compare and contrast DNA and RNA.

**DNA:** Deoxyribonucleic Acid is the instruction booklet for making all of an organism's proteins. The DNA contains sections (genes) that code for specific proteins. DNA has the sugar deoxyribose, contains the nitrogen base Thymine (G = C, A = T), and is double stranded. It stays in the nucleus.

**RNA:** Ribonucleic Acid is used in the process of building the proteins. RNA has the sugar ribose, contains the nitrogen base Uracil (G = C, A = U), and is single stranded. It can move from the nucleus into the cytoplasm.

**DNA and RNA:** Both are nucleic acids, which means they are made of nucleotides that contain a phosphate group, pentose sugar, and nitrogenous base. DNA and RNA both have the nitrogen bases Guanine (G), Cytosine (C), and Adenine (A).

5. I can explain how organelles work together to make, package, and export proteins.

The Central Dogma of Biology is DNA → RNA → Protein.

Proteins are the product of the cell. Sections of DNA, called genes, contain the instructions for making proteins. The DNA is found in the Nucleus of the cell. Transcription, the first step of protein synthesis, occurs in the nucleus. Translation, the second step of protein synthesis, occurs at the ribosomes. The Ribosomes build the proteins by linking amino acids together. These Ribosomes can either be free in the cytoplasm or attached to the Rough Endoplasmic Reticulum.

Free Ribosomes make proteins for that cell and Attached Ribosomes make proteins for export. The Rough ER helps modify proteins by ensuring that the proteins are folded into the correct shape and then transports them to the Golgi Apparatus. The Golgi Apparatus sorts the proteins, labels them with carbohydrates, and packages them inside a phospholipid bilayer called a vesicle. The Vesicle takes the protein through the cytoplasm to the Plasma Membrane for exocytosis (the vesicle fuses with the membrane and releases the proteins outside of the cell).
6. I can explain how mutations affect how a protein works.

A mutation is a mistake that can affect a single gene or an entire chromosome. Chromosomal mutations can occur when the sequence genes in a chromosome is changed (see diagram). Chromosomal mutations affect how multiple proteins are made and generally cause severe disorders.

Gene mutations affect how a single protein is formed.

A **Point Mutation** is a mutation that affects only one amino acid. This is sometimes called a Substitution Mutation because one base pair is swapped for another.

**EXAMPLE:** THE CAT ATE THE RAT \( \rightarrow \) THE CAT ARE THE RAT

A **Frameshift Mutation** occurs because of the Insertion or Deletion of a base pair in the DNA sequence. This creates a problem in how the mRNA is read for every amino acid after the mutation because codons always consist of 3 bases. If one base is added or deleted, the codon sequence is shifted and the entire amino acid sequence will be wrong. **EXAMPLE:** THE CAT ATE THE RAT \( \rightarrow \) THE CAT AET HER AT

Proteins must have the correct sequence of Amino Acids in order to work properly. If the sequence of Amino Acids is wrong, the protein will not fold correctly. This means that the protein will not be shaped correctly so it will not function correctly (Shape = Function).
7. I can transcribe a sequence of DNA into mRNA.
   Transcription: The DNA sequence is replaced with the complementary RNA sequence. G bonds with C.
   RNA does not have T, so A bonds with U.

8. I can use a codon chart to translate a sequence of mRNA into amino acids.
   The mRNA sequence is read in 3 base sequences called codons. Each codon specifies one amino acid.
   3 Bases = 1 Codon = 1 Amino Acid
   There are 20 amino acids, so some amino acids have multiple codons. During Translation, tRNA uses
   anticodons to determine which amino acids match with the codon. Translation ALWAYS begins with
   the START Codon AUG. Transcription ends with 1 of 3 STOP Codons: UAA, UAG, UGA.
   A Codon Chart (on the next page) can be used to serve the same function as tRNA.
   The amino acid sequence determines the Protein (polypeptide).

Codons Found in Messenger RNA

<table>
<thead>
<tr>
<th>Second Base</th>
<th>U</th>
<th>C</th>
<th>A</th>
<th>G</th>
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<tr>
<td>U</td>
<td>Phe Ser Tyr Cys</td>
<td>U</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phe Ser Tyr Cys</td>
<td>C</td>
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<td></td>
<td>Leu Ser Stop Trp</td>
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<tr>
<td></td>
<td>Leu Pro His Arg</td>
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<td>Leu Pro His Arg</td>
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<td></td>
<td>Leu Pro Gln Arg</td>
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<td>Leu Pro Gln Arg</td>
<td>A</td>
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<tr>
<td></td>
<td>Ile Thr Asn Ser</td>
<td>C</td>
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<td>Ile Thr Asn Ser</td>
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<td></td>
<td>Ile Thr Lys Arg</td>
<td>C</td>
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<tr>
<td></td>
<td>Val Ala Asp Gly</td>
<td>T</td>
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<td>Val Ala Glu Gly</td>
<td>A</td>
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</tbody>
</table>

Gene (DNA) → mRNA → Protein (polypeptide)