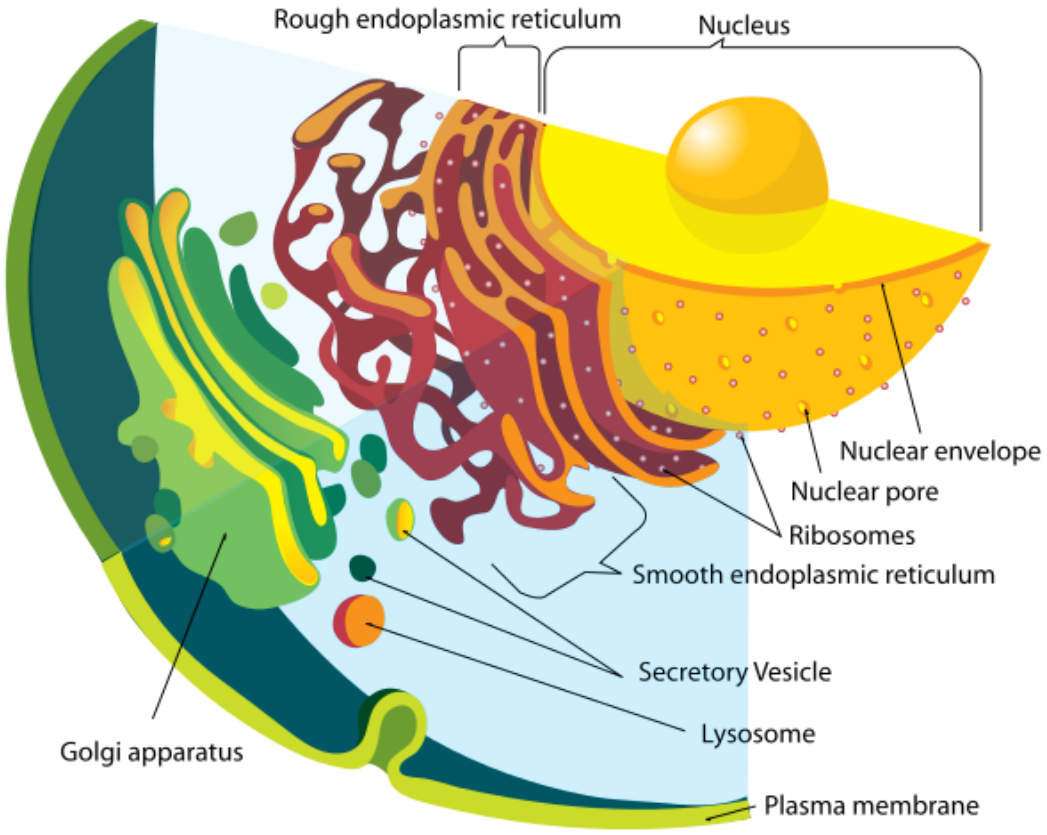
5.2

Cell Structures

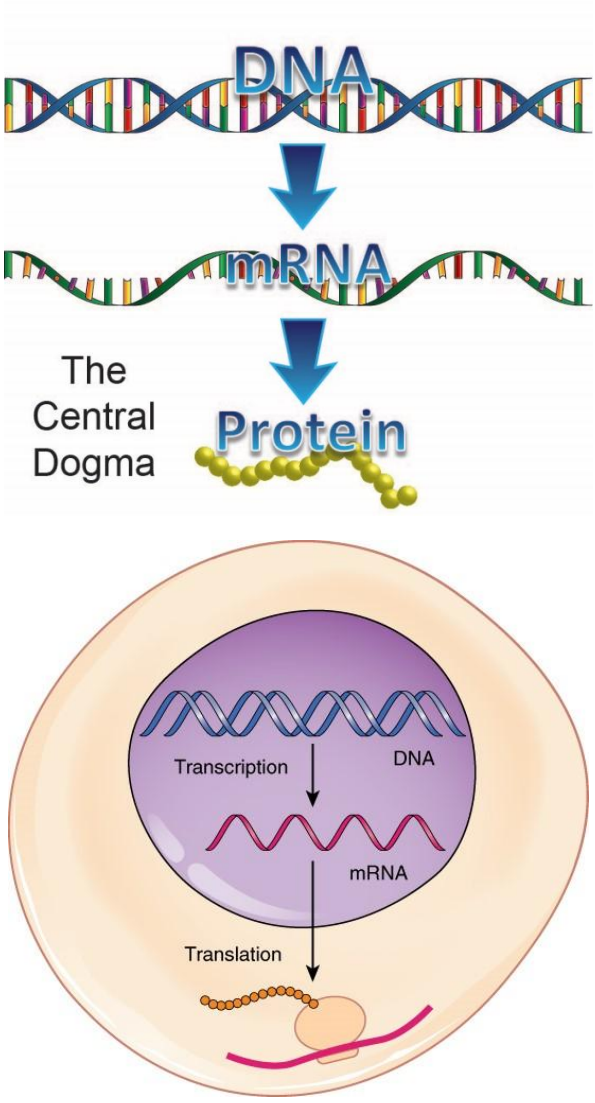
As technology progressed to the point of peering deeper and deeper into the world of the cell, it became apparent that the cell cytoplasm, when viewed under a light microscope, was full of even smaller intracellular structures. The structures are collectively called cellular organelles.

To help illustrate the function of many of these organelles, let us consider the secretion of insulin by beta cells in the pancreas. In order to secrete insulin, the cell must first make it. This process starts in the cell **nucleus**. The nucleus houses the genetic material (DNA) of a human cell and provides a location for **DNA transcription** (the copying of DNA). Importantly, the nucleus is surrounded by two distinct lipid bilayer membranes. The outer membrane belongs to the **endomembrane system** (made up of the nuclear envelope, the endoplasmic reticulum, the golgi apparatus, lysosomes, the plasma membrane, and most vacuoles and vesicles).



Endomembrane System Diagram. *Title: File: Endomembrane system diagram en.svg; Mariana Ruiz LadyofHats; Site: http://en.wikipedia.org/wiki/File:Endomembrane_system_diagram_en.svg; License: Public Domain.*

The production and secretion of insulin helps illustrate the coordinated efforts of the organelles in this system. Within the nucleus, the insulin gene is *transcribed* from DNA to RNA and then further processed into messenger RNA or mRNA. This mRNA is then transported out of the nucleus to **ribosomes** docked to the surface of the **endoplasmic reticulum** (ER). The ER is divided into two components: the rough ER and the smooth ER. The rough ER is named "rough" because it is studded with ribosomes, which create a bumpy surface when viewed under an electron microscope. The function of the ribosome is to perform **translation** (the use of mRNA as a template to synthesize protein). The ribosome is specifically suited to interpret the mRNA nucleotide acid code and assign the appropriate amino acid in the creation of a polypeptide chain. This is the first step of making a protein.



Central Dogma of Biology - DNA Transcription to Translation. File:0328 Transcription-translation Summary.jpg; Author: OpenStax College; Site:http://commons.wikimedia.org/wiki/File:0328_Transcription-translation_Summary.jpg; License: This file is licensed under the Creative Commons Attribution 3.0 Unported license.

Within the rough ER, the nascent (immature) insulin protein is folded into primary, secondary, and tertiary structures. It is then transported to the **Golgi apparatus**. The Golgi apparatus is the location for processing and sorting (think of a giant UPS mail warehouse). Within the Golgi, the nascent insulin is further processed into mature (functional) insulin and packaged into secretory vesicles. These vesicles (now full of insulin) bud off the Golgi and are transported, via microtubules, to the **plasma membrane** where they await the proper signal for secretion. Secretion occurs as the vesicle fuses with the **plasma membrane**, expelling its contents into the extracellular space in a process known as exocytosis.

Now that you understand the process of how cells can create and secrete insulin let us now examine the roles of each of these organelles in greater detail.

*It should be noted that two major cell types exist, **prokaryotic** and **eukaryotic**. Prokaryotic cells far out number eukaryotic cells, but eukaryotic cells are larger so that the collective mass between the two is about equal. Eukaryotic cells typically contain membrane bound organelles and as such will be used first to discuss the functions of organelles.*

The Cell Nucleus
The Endoplasmic Reticulum
The Golgi Apparatus
Lysosomes, Proteasomes, and Peroxisomes
Vacuoles
The Mitochondrion
Chloroplasts