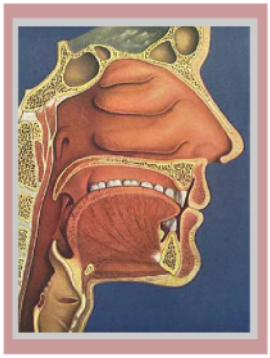
Simple Schooling

# Human Anatomy & Physiology I



By J. Anne Huss

# 2.2 Cell Junctions

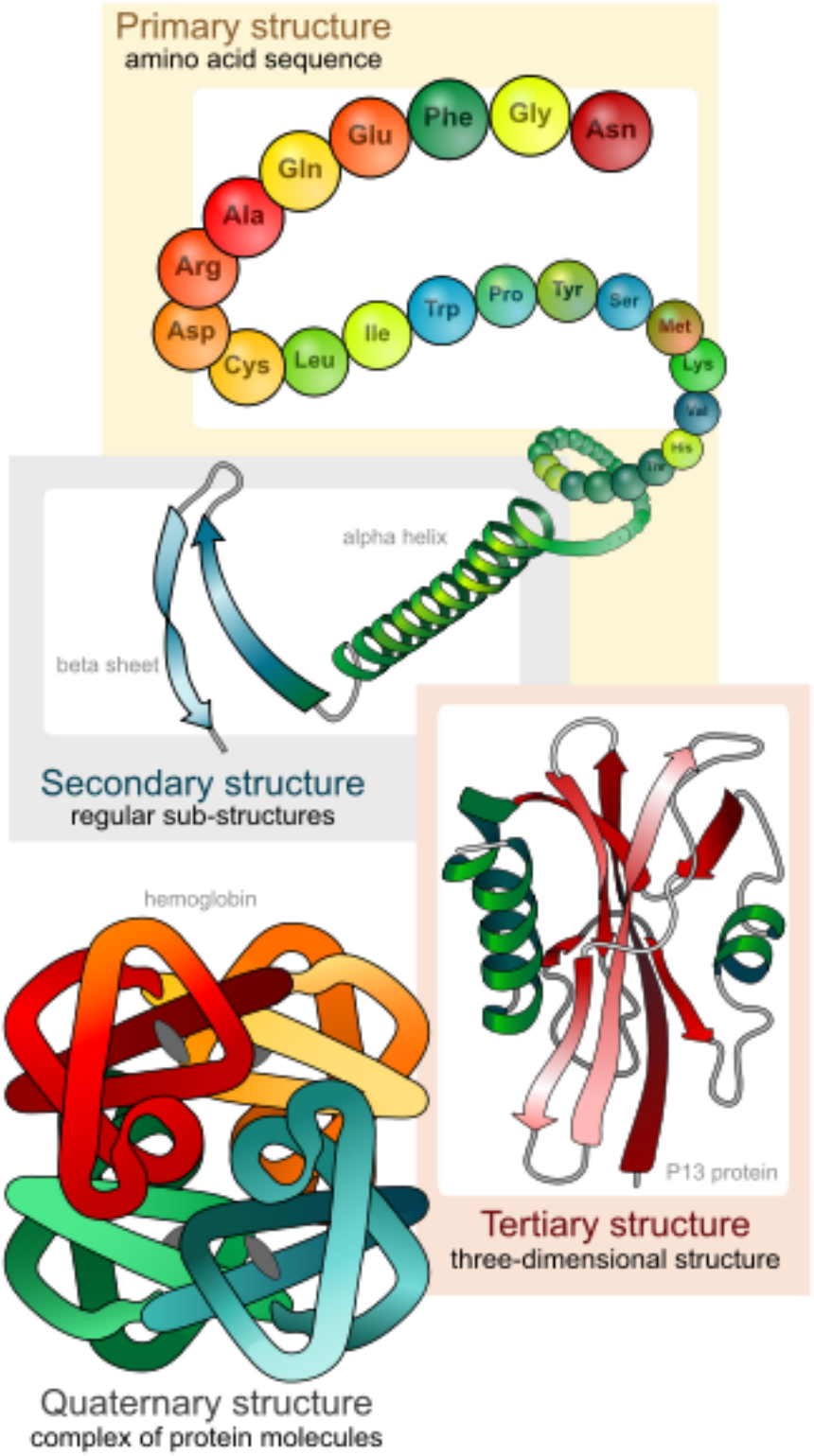
**Cell junctions** are very important for the overall health and function of an organism. Sometimes these cellular junctions let things pass through pretty easily, and other times not very much at all can get by.

Before we talk about junctions we should first talk about proteins. **Proteins** are a string of amino acids that fold up to form a three dimensional shape. This shape is unique and special. In fact, it is the shape of a protein that dictates what it can and cannot do.

Unit Two contains many different **extracellular proteins** which are different from the proteins contained inside the cell, however all proteins are made inside the cell because that is the only place where the DNA can be transcribed and the subsequent RNA can be transcripted. If you remember back to biology, those two processes are called **trancription** and **translation**. Translation is the process by which the strand of RNA is "read" by the ribosome, and the resulting protein that RNA codes for is produced.

Another thing you might remember from biology is that there are 20 **amino acids** and those 20 amino acids are the building blocks of proteins. Each protein contains a very specific and precise sequence of amino acids that are strung together in exactly the same way, every single time, to form a protein. If even ONE single amino acid is misplaced, the result will not be the correct protein.

Proteins have four types of structures: **Primary, Secondary, Tertiary, and Quanternary.**



The most important things about the above diagram are the **secondary and tertiary structures**. You see, all amino acids have a little charge on them. Some have a negative charge (-), and some have a positive (+) charge. A few are a little bit of both. If you have ever done experiments with magnets you will remember that if you try to force the positives sides of two magnets together they repel each other, (and vice versa with the negatives). It just so happens that amino acids react in a similar fashion when they are confronted with another amino acid with either alike or unlike properties. They can repel or be attracted to one another.

The secondary and tertiary structures above are examples of this **attraction** and **repulsion**. Sometimes, when just the right amino acids are lined up together they bend into what is called a **pleated sheet**. Other times, when the conditions are just so, they twist into an **alpha helix** (sort of like DNA, except DNA is not a protein – it is a **nucleic acid**). These structures help form the tertiary structure, which allows the string of alpha helices and pleated sheets to either attract or repel each other and form a specific shape.

**That specific shape determines the function of that protein**. That is a very important point so let me repeat it: **The specific shape of a protein determines the function of that protein**.

Very complex proteins can be made by two proteins being attracted to one another to form a **quaternary structure**. In later units you will learn about hemoglobin, a very famous quaternary structure in blood.

You are probably wondering why I am telling you all of this - if this section of the unit is about cell junctions – but I have a good

reason. You see, you cannot possibly understand what a cellular junction is without understanding that they are made up of proteins, and that these particular proteins, for the most part, are extracellular.

Remember that inside the cell DNA was replicated, shuttled out of the nucleus as RNA, attached to the ribosome, and a protein was translated from that RNA chain.

OK - That protein can be shuttled to any number of organelles (Golgi, mitochondria, lysosome etc.) inside the cell **or** they can be taken to the plasma membrane by a vesicle and transported through the membrane to the outside of the cell.

That outside space between each cell is called the **extracellular matrix,** and any protein that functions outside of the cell is called an **extracellular protein**.

Cell junctions occur *between the cells* and there are three main types:

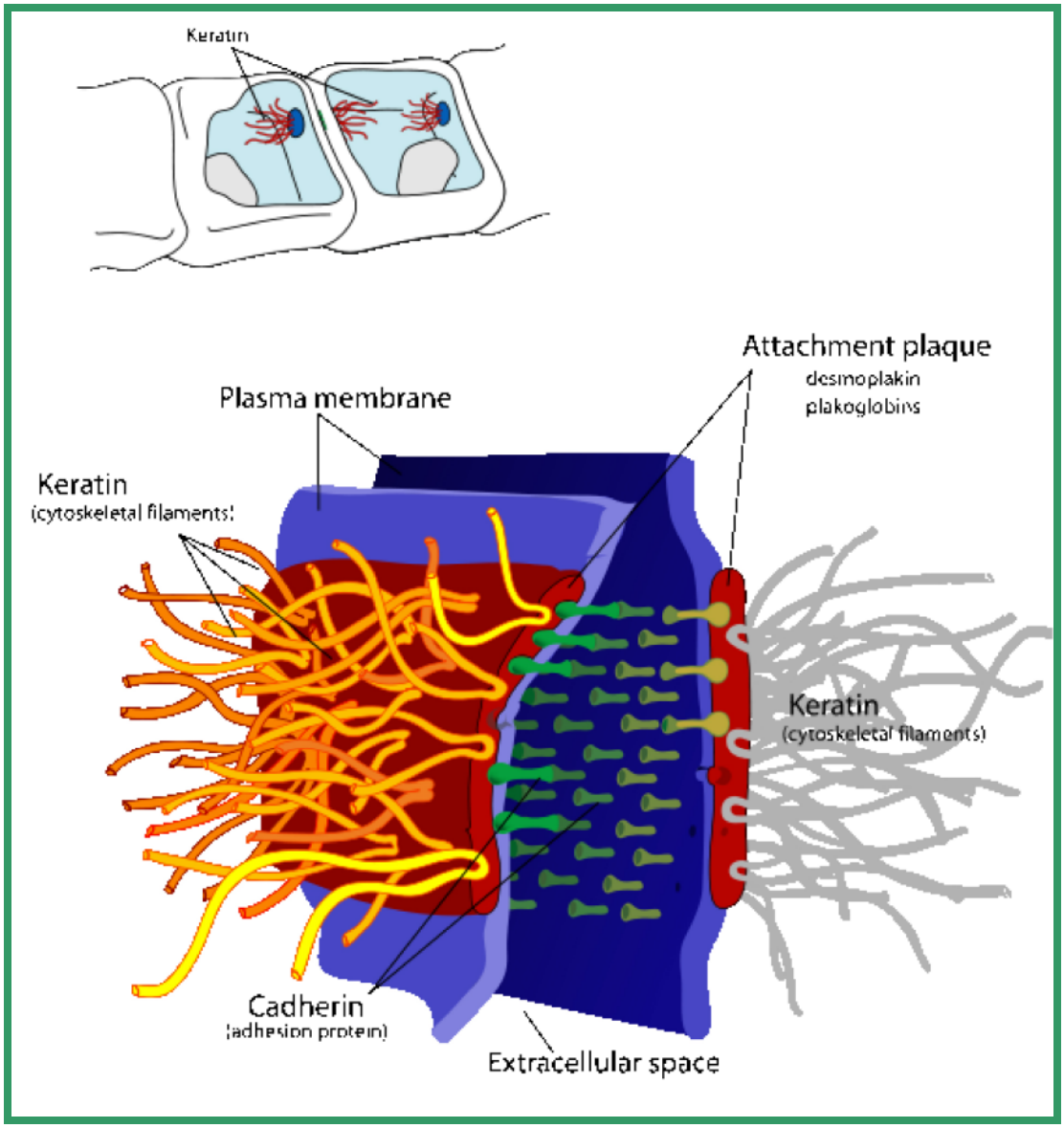
- **Anchoring junctions**
- **Occluding junctions**
- **Communicating junctions**

Before we continue – what does the word junction mean to you? A junction is simply a meeting place – it can be a place where two roads meet or two cells meet. In our case, it is the latter. Cellular junctions can be compared to mortar and cells can be bricks. The bricks will never be able to become a building if there isn't something to stick all the bricks together to give it a shape.

**Anchoring junctions** – are like mortar – they stick the cells together. They do this by attaching one cell's cytoskeleton to the neighboring cell's cytoskeleton (microtubules etc) **or** directly to the extracellular matrix.

The two **anchoring junctions** we will be talking about are the **desmosomes** and the **hemidesmosomes**. Look at the diagrams below before reading on:

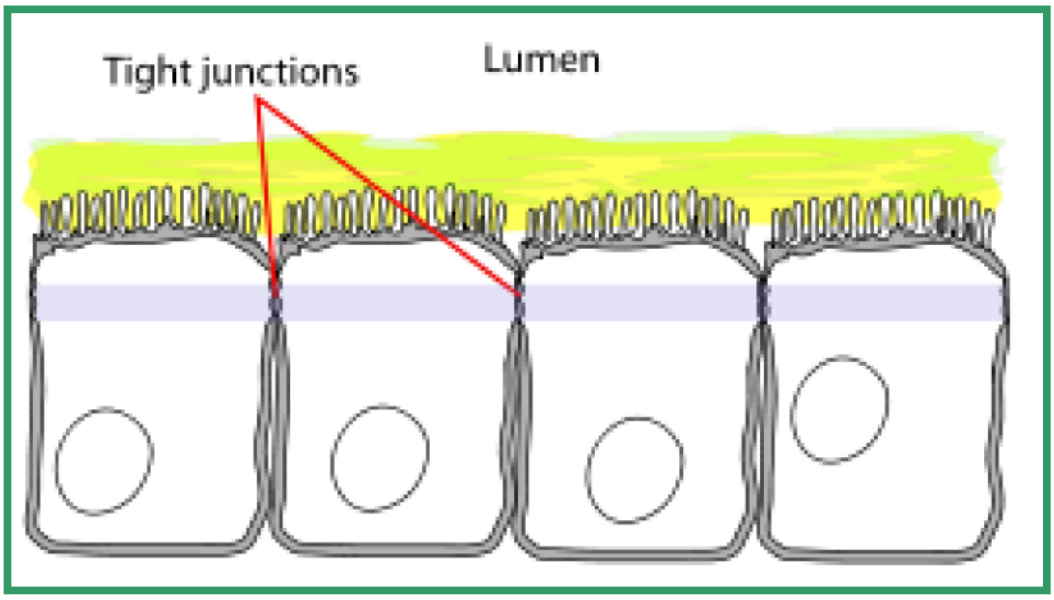
Desmosomes:



In this diagram you should notice the following:

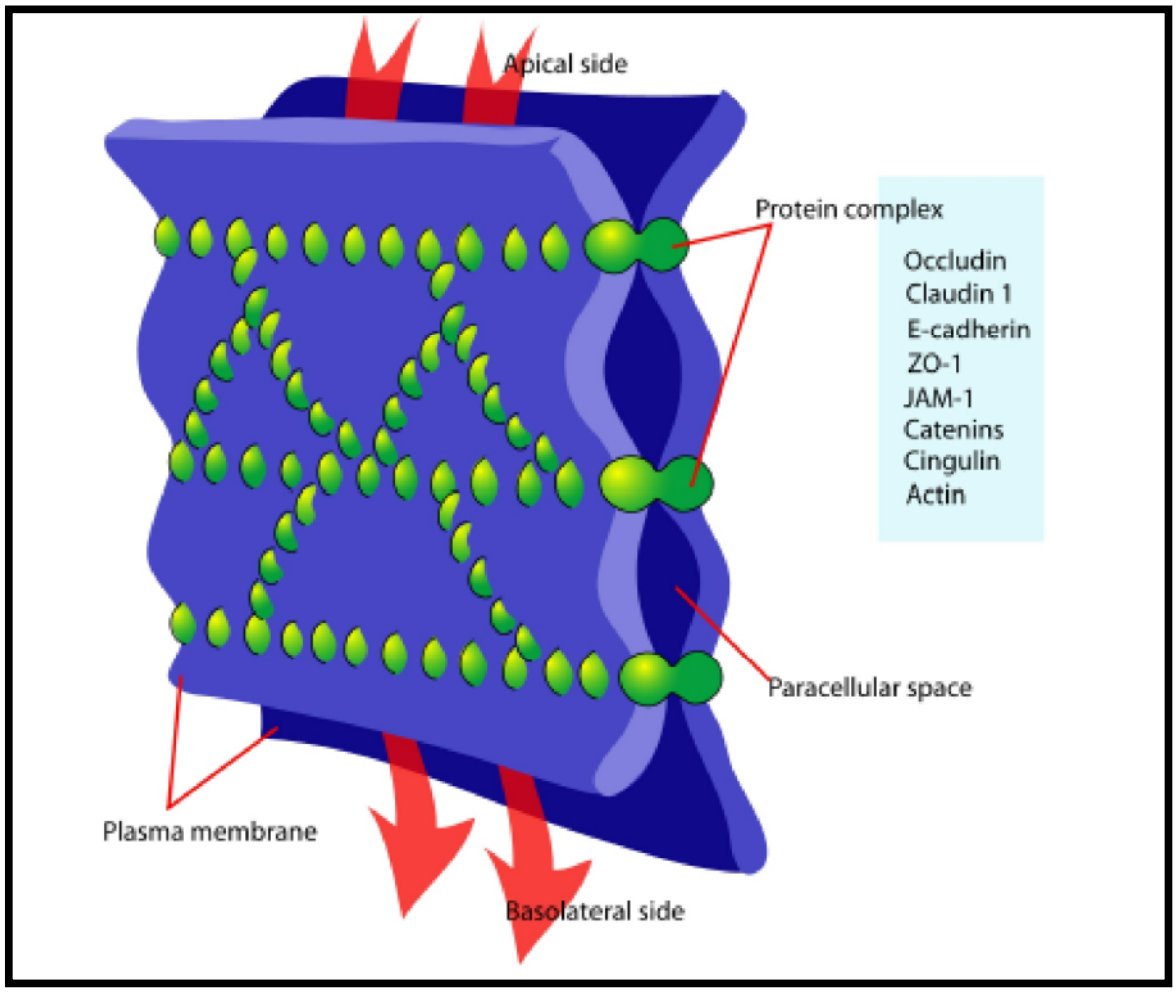
- The junctions occur between two cells
- The proteins involved in desmosomes are **keratin**, and **cadherin**
- The hemidesmosomes are not shown, but they occur between the cell and basal lamina instead of between the cells
- The proteins (keratin filaments and cadherin) that help anchor the cells are located inside the plasma membrane and continue into both the intracellular and extracellular spaces
- Cells that span the plasma membrane are called **Transmembrane proteins**

The next type of junction is the **occluding junction, or tight junction**. To occlude means to close shut and that is exactly what tight junctions do. They close off the spaces between two cells.



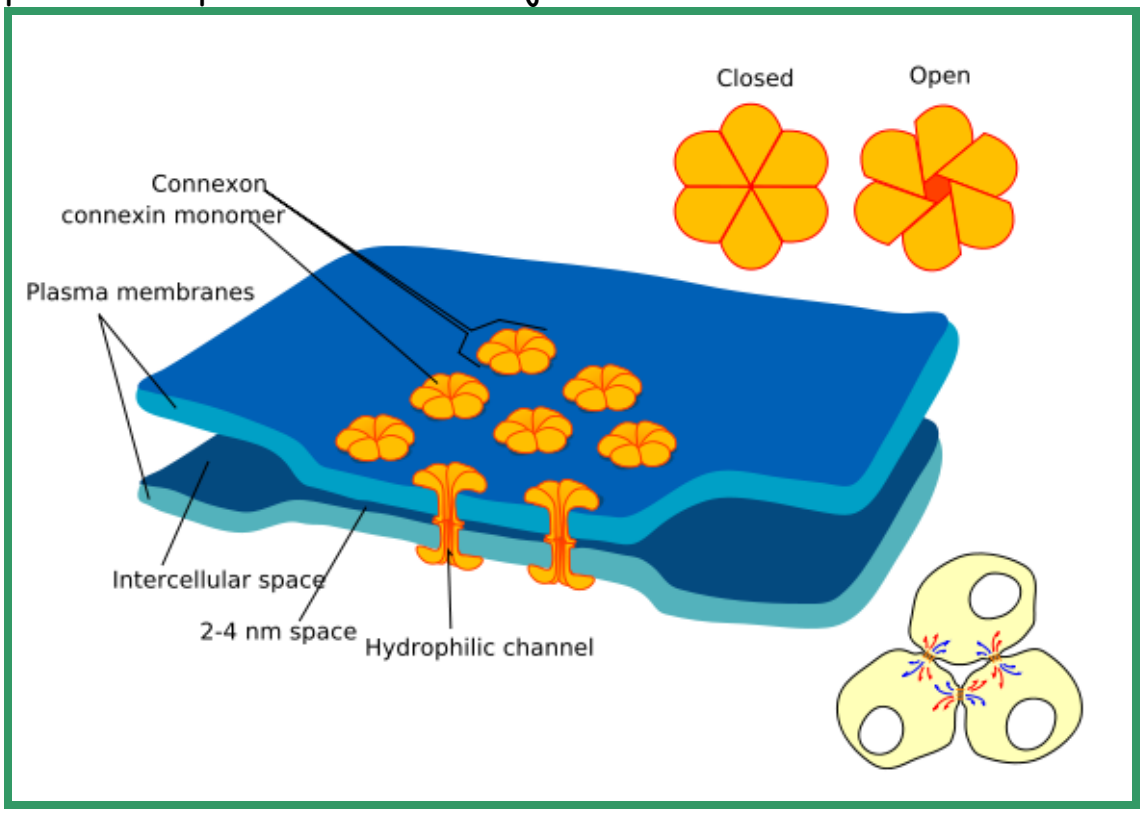

These junctions perform a crucial function – they severely limit the type and size of molecule that can pass between the cells of the epithelial layer. The best example of a tight junction is in

the blood brain barrier where only very specific molecules are allowed to pass between the epithelial cells and enter the brain.




Another place where there are tight junctions is in the placenta of the developing baby. These tight junctions permit or forbid chemicals taken by a pregnant mother from entering the circulatory system of the baby. The BBB (**blood brain barrier**) is much more selective than the placenta and that is why pregnant mothers are cautioned to not take any type of drug or become exposed to certain chemicals during gestation. There are many different proteins associated with tight junctions, most notably are occludin, E-cadherin, and actin.

The **communicating junctions**, or **gap junctions**, are the last type we will discuss. These are **transmembrane proteins** that allow **ions** (sodium, potassium, chloride) to move between cells. The protein responsible for these junctions is **connexon**.




The diagram above shows the following:

- The protein connexon is what makes up the channel that spans between the two plasma membranes of each cell
- It takes 6 connexon **monomers** to make one channel
- The connexon will open and close based on certain conditions
- The channels made by the connexon is hydrophilic (water loving)
- The connexon channel is made up of small individual monomers that join together to form a more complex molecule
- The connexon channel spans a space of about 2-4 nanometers (equal to one billionth of a meter)

**2.2**
**Questions:**

**What is a protein?**

**Briefly describe transcription and translation:**

**What is an amino acid?**

**What will happen if one of these amino acids is in the wrong place in the chain?**

**Name the four structures of proteins and describe each one:**

**What are the three types of cellular junctions and describe each one?**

**Name the major proteins associated with each type of junction:**