Cell-cell junctions

Different types of intercellular junctions, including plasmodesmata, tight junctions, gap junctions, and desmosomes.

Introduction

If you were building a building, what kinds of connections might you want to put between the rooms? In some cases, you'd want people to be able to walk from one room to another, in which case you'd put in a door. In other cases, you'd want to hold two adjacent walls firmly together, in which case you might put in some strong bolts. And in still other cases, you might need to ensure that the walls were sealed very tightly together – for instance, to prevent water from dripping between them.

As it turns out, cells face the same questions when they're arranged in a tissue next to other cells. Should they put in doors that connect them directly to their neighbours? Do they need to spot-weld themselves to their neighbours to make a strong layer, or perhaps even form tight seals to prevent water from passing through the tissue? Junctions serving all of these functions can be found in cells of different types, and here, we'll look at each of them in turn.

Plasmodesmata

Plant cells, surrounded as they are by cell walls, don't contact one another through wide stretches of plasma membrane the way animal cells can. However, they do have specialized junctions called **plasmodesmata** (singular, **plasmodesma**), places where a hole is punched in the cell wall to allow direct cytoplasmic exchange between two cells.

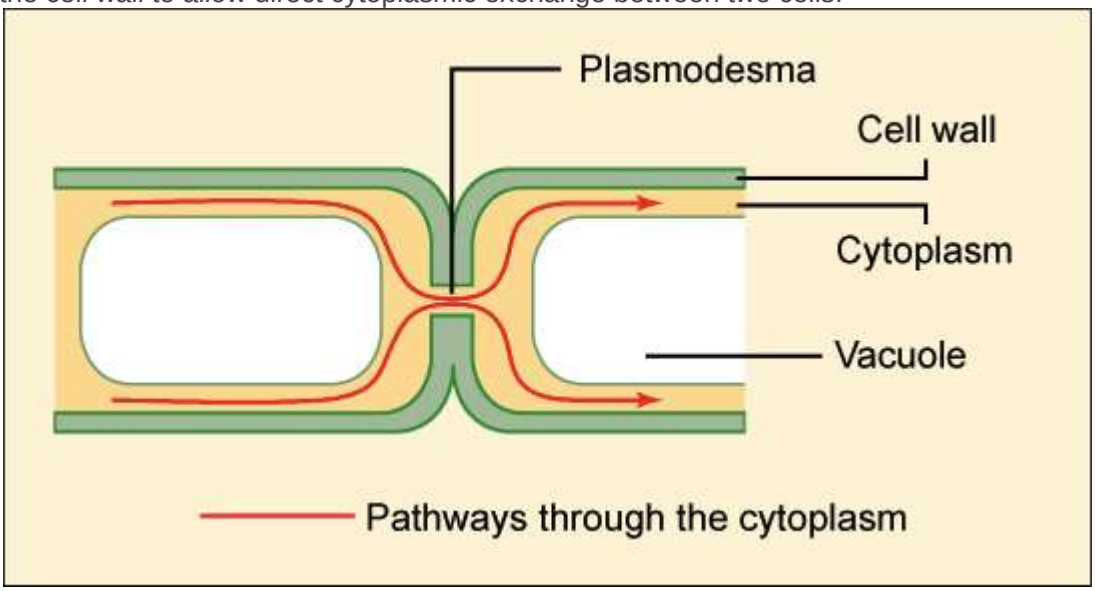

Image of two cells connected by a plasmodesma, showing how materials can travel from the cytoplasm of one cell to the next via the plasmodesma.

Image credit: OpenStax Biology.

Plasmodesmata are lined with plasma membrane that is continuous with the membranes of the two cells. Each plasmodesma has a thread of cytoplasm extending through it, containing an even thinner thread of endoplasmic reticulum (not shown in the diagram above).

Molecules below a certain size (the size exclusion limit) move freely through the plasmodesmal channel by passive diffusion. The size exclusion limit varies among plants, and even among cell types within a plant. Plasmodesmata may selectively dilate (expand) to allow the passage of certain large molecules, such as proteins, although this process is poorly understood[1,2].

Gap junctions

Functionally, **gap junctions** in animal cells are a lot like plasmodesmata in plant cells: they are channels between neighbouring cells that allow for the transport of ions, water, and other substances. Structurally, however, gap junctions and plasmodesmata are quite different.

In vertebrates, gap junctions develop when a set of six membrane proteins called **connexins** Forman elongated, donut-like structure called a **connexion**. When the pores, or "doughnut holes," of connexions in adjacent animal cells align, a channel forms between the cells. (Invertebrates also form gap junctions in a similar way, but use a different set of proteins called innexins.)[4]

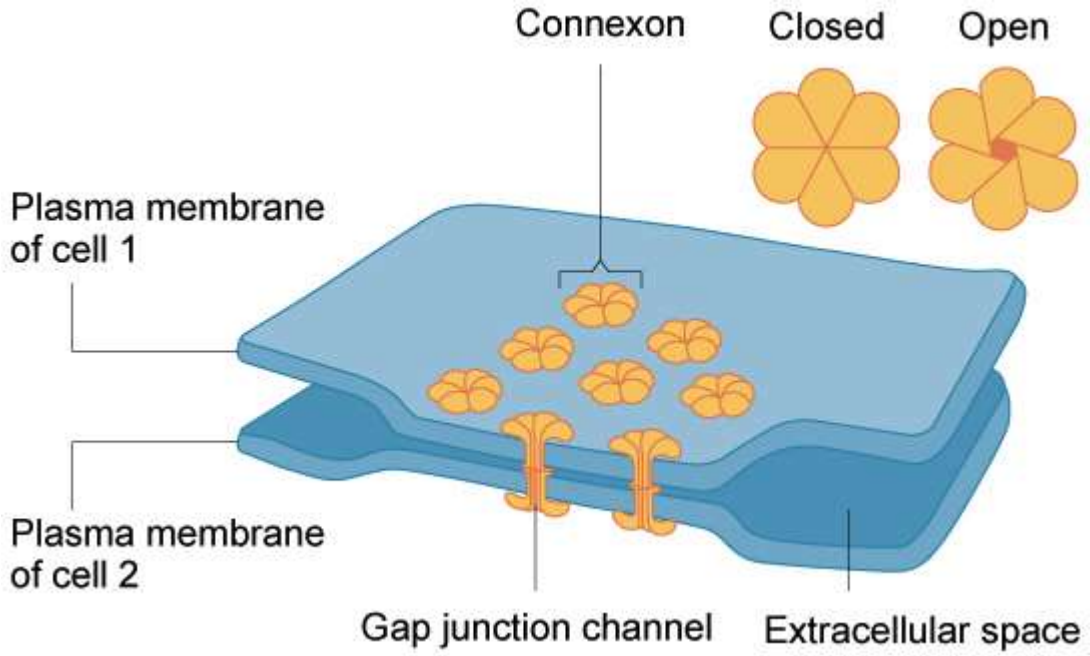

Image of the plasma membranes of two cells held together by gap junctions. Where two connexions from the different cells meet, they can form a channel leading from one cell into the next.

Image credit: OpenStax Biology. Modification of work by Mariana Ruiz Villareal.

Gap junctions are particularly important in cardiac muscle: the electrical signal to contract spreads rapidly between heart muscle cells as ions pass through gap junctions, allowing the cells to contract in tandem.

Tight junctions

Not all junctions between cells produce cytoplasmic connections. Instead, **tight junctions** create a watertight seal between two adjacent animal cells.

At the site of a tight junction, cells are held tightly against each other by many individual groups of tight junction proteins called **claudins**, each of which interacts with a partner group on the

opposite cell membrane. The groups are arranged into strands that form a branching network, with larger numbers of strands making for a tighter seal[5].

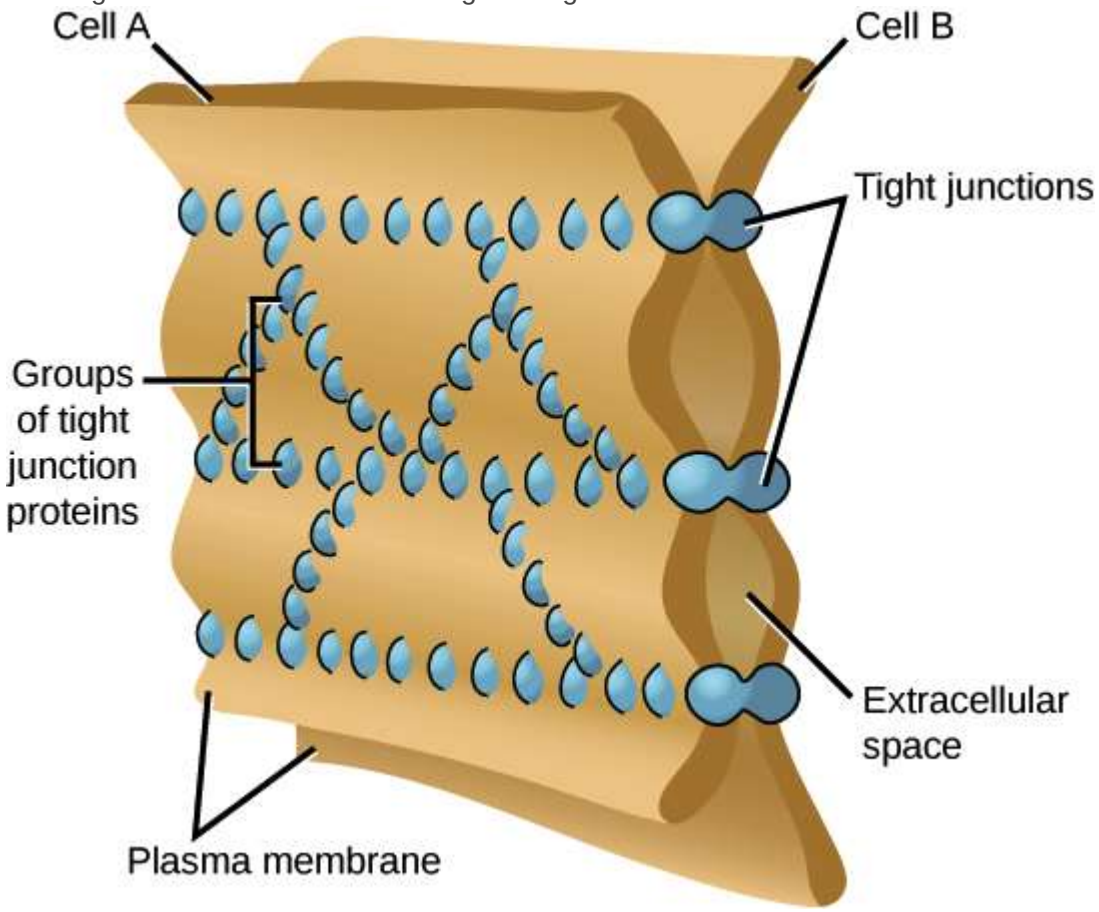

Image of the membranes of two cells held together by tight junctions. The tight junctions are like rivets, and they are arranged in multiple strands that form lines and triangles.

Image credit: OpenStax Biology. Modification of work by Mariana Ruiz Villareal.

The purpose of tight junctions is to keep liquid from escaping between cells, allowing a layer of cells (for instance, those lining an organ) to act as an impermeable barrier. For example, the tight junctions between the epithelial cells lining your bladder prevent urine from leaking out into the extracellular space.

Desmosomes

Animal cells may also contain junctions called **desmosomes**, which act like spot welds between adjacent epithelial cells. A desmosome involves a complex of proteins. Some of these proteins extend across the membrane, while others anchor the junction within the cell.

Cadherin's, specialized adhesion proteins, are found on the membranes of both cells and interact in the space between them, holding the membranes together. Inside the cell, the cadherin's attach to a structure called the cytoplasmic plaque (red in the image at right), which connects to the intermediate filaments and helps anchor the junction.

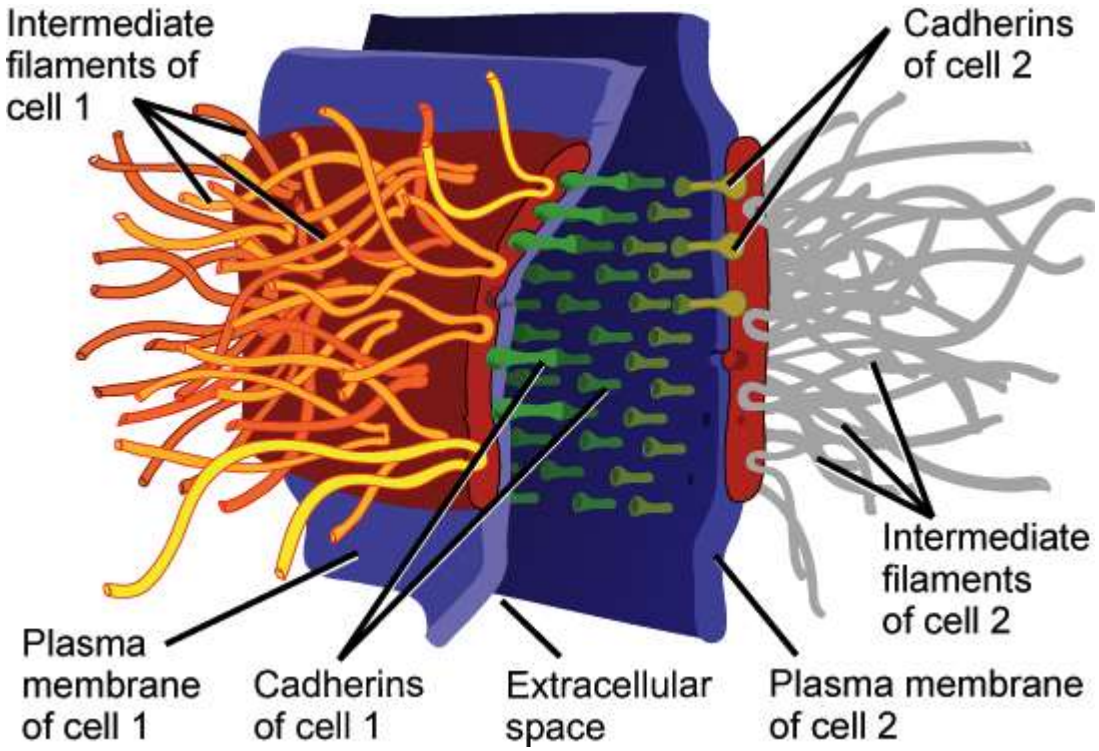

Image credit: OpenStax Biology. Modification of work by Mariana Ruiz Villareal.

Desmosomes pin adjacent cells together, ensuring that cells in organs and tissues that stretch, such as skin and cardiac muscle, remain connected in an unbroken sheet.