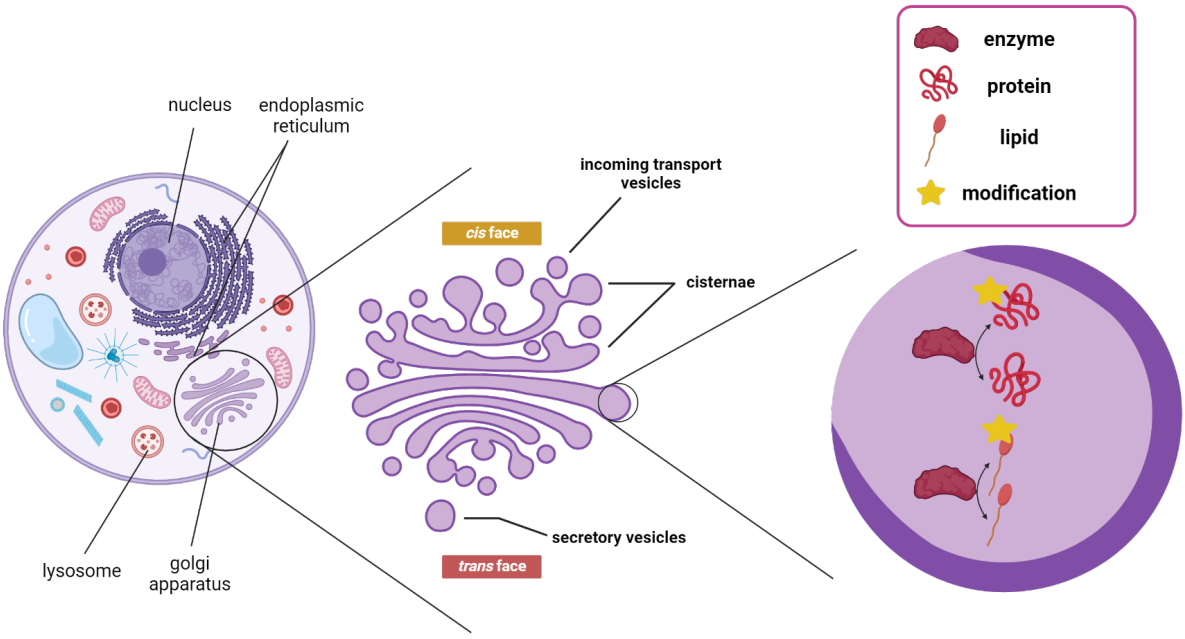
Golgi Apparatus

(Natalia Moreno de Castro & José Manuel Borrero de Acuña)



Created by Biorender

What function does it serve?

The Golgi apparatus is a eukaryotic organelle (subcellular compartment that has one or more specific jobs to perform in the cell) that works as a factory in which proteins (drivers of all cellular functions) and lipids (constituents of the cell envelope) are modified and sorted to be sent to their final destinations. The modification of proteins and lipids are often crucial for them to be able to conduct their functions, and thus the Golgi apparatus serves a vital function for the eukaryotic cell. It also participates in the formation of lysosomes (cellular organelles that contain digestive enzymes) and plays an essential role in the secretion of proteins out of the cell (certain proteins fulfil their function outside of the cell), since the secretion vesicles are released from this apparatus.

What does it look like? How big is it?

The Golgi apparatus consists of a series of flattened, disc-shaped sacs known as cisternae that are grouped one on top of the other. It also has small vesicles surrounding it, which are responsible for transporting materials between the endoplasmic reticulum (ER), the Golgi and other parts of the eukaryotic cell. It has differentiated parts: the *cis* face, which is the receiving side, is located near the ER and it receives vesicles loaded with proteins and lipids that have been synthesized in the reticulum; the Medial Cisternae, the central part of the system, in where most of the processing and modification of lipids and proteins occur; and the *trans* face, which is the shipping side, where modified molecules are packaged into vesicles and sent to their final destinations, such as lysosomes, the plasma membrane, or outside the cell.

The size of the Golgi apparatus can vary significantly, but usually measures around 1 to 3 micrometres (µm) in diameter. The variations in the size can be due to the cell type and its activity

– cells that are actively involved in secretion, such as glandular cells or cells in the pancreas, have a larger apparatus – and also the number of cisternae, which can range from 3 to 10 cisternae per apparatus, but this number is increased in cells with high secretory functions.

How does the cell make it?
On one hand, the Golgi apparatus is primarily originating from the ER, since Golgi's components are initially derived from the ER: the Golgi cisternae are continuously regenerated as they mature from the *cis* to the *trans* face in a process called cisternal maturation. On the other hand, during mitosis, the Golgi apparatus breaks down into vesicles and tubules that are evenly distributed between the daughter cells, and after cell division, these fragments reassemble to form the Golgi stacks in each daughter cells. Finally, there are numerous proteins specified in the cell's genome that have different functions in the Golgi apparatus, for example coat proteins, that play essential roles in vesicle formation and transport, or matrix proteins that provide a scaffold that helps preserve the architecture of the apparatus.

How does it work?
Proteins and lipids synthesized in the ER are transported in vesicles and received in the *cis* face of the Golgi apparatus. These molecules are modified by specific enzymes as they pass through the different cisternae from the *cis* to the *trans* face. The modifications include glycosylation (addition or alteration of sugar molecules), phosphorylation (addition of phosphate groups), sulfation (addition of sulfate groups), and proteolysis (cleaving of large inactive proteins into smaller active forms). During these modifications, sorting signals are added, tags that help direct the molecules to their correct destinations. At the *trans* face, the modified molecules are packaged into vesicles and shipped to their final destination, which can be extracellular (secretion), lysosomes or the membrane of the cell or other organelles.

Where is it found? Which organisms?
The Golgi apparatus is often found close to the nucleus and the ER. In plant cells, multiple small Golgi stacks, called dictyosomes, are scattered around the cytoplasm rather than being clustered in one location. The Golgi apparatus is found in eukaryotic organisms, which include animals, plants, fungi and protists. These last two groups include microorganisms.

Some numbers
Usually, in animal cells, there is just one Golgi apparatus per cell, that has from 3 to 10 cisternae; in plant cells, the number of dictyosomes vary from a few dozen to several hundred; in single-celled protists, the number of dictyosomes also vary from a few to several; and in fungal cells, the number is fewer compared to plant cells. Depending on the activity of the cells, the number of proteins processed every day by the Golgi apparatus vary a lot, but it ranges from tens of thousands to millions of proteins per day.

Its importance to the microbe?
The Golgi apparatus is a vital organelle in eukaryotic cells, since it carries out several functions that are crucial for the survival and housekeeping of cells: modification of proteins and lipids, secretion of cellular products, formation of lysosomes, synthesis of polysaccharides, membrane formation and renewal, regulation of cell signalling and communication and stress response.

Its importance to us?
Yeast and other fungi are used as cell factories for the production of recombinant proteins, enzymes and antibodies, because of their ability to perform complex glycosylation (one of the protein modifications aforementioned). Also, fungi and protists are sources of bioactive compounds such as antibiotics, antifungals and anticancer agents. The Golgi apparatus is essential for the production of all of these molecules, which are relevant for biomedicine and biotechnology.

In the food industry, yeast cells employed in fermentation processes, like bread- and beverage production, require the Golgi apparatus.

In the health industry, pathogenic protists and fungi have a Golgi apparatus that is crucial for their pathogenicity, being, for example, the organelle where virulence factors are produced, so understanding its function can aid in developing drugs to treat infections.

Lastly, yeast, and particularly *Saccharomyces cerevisiae*, serves as a model organism for studying cellular processes, including Golgi function. These studies have provided insights into fundamental mechanisms of protein processing, trafficking, and cellular regulation that are applicable to human biology.

The Golgi apparatus is an all powerful cellular machine refining newly-made raw and immature cellular materials into the mature, refined, tuned and active products needed by the cell, and targeting them to their final destinations where they fulfil their tasks.