**Chapter 1 - Membranes**

**Abstract**

All biotechnologies involve cells at some level. Common biotechnologies entail communication or manipulation of cells, often by the delivery of drugs, [signaling molecules](https://www.sciencedirect.com/topics/medicine-and-dentistry/signaling-molecules%22%20%5Co%20%22Learn%20more%20about%20Signaling%20Molecule%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages), or other bioactive agents. In order for such agents to operate, interaction with the cell membrane will have to occur. The cell membrane separates the inside of the cell from the extracellular environment. Signals can cross the membrane either by traversing the membrane or by interacting with the extracellular face of the membrane and having the event indicated somehow on the cytoplasmic face of the cell. Before we deliver a drug or a signal to a cell, we should first understand what the cell membrane is. In this chapter, we will discuss the composition and function of the plasma membrane.

**Keywords**

Lipid

Fatty acid

Phospholipid

Amphipathic

Phosphatidylethanolamine

Phosphatidylserine

Phosphatidylcholine

Cholesterol

Protein

**Chapter 2 - Cellular Transport**

**Abstract**

Now that the structure and function of the cell membrane have been described, we turn to how molecules cross this barrier. Some molecules are able to gain access to the [cytoplasm](https://www.sciencedirect.com/topics/medicine-and-dentistry/cytoplasm%22%20%5Co%20%22Learn%20more%20about%20Cytoplasm%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages) through channels, some are carried across via [transmembrane proteins](https://www.sciencedirect.com/topics/medicine-and-dentistry/membrane-protein%22%20%5Co%20%22Learn%20more%20about%20Membrane%20Protein%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages), and still others enter the cell as parts of the membrane itself pinch off to create vesicles. A specialized type of protein, the [membrane receptor](https://www.sciencedirect.com/topics/medicine-and-dentistry/membrane-receptor), is used by the cell to grab specific molecules from the outside of the cell for transport to the inside of the cell via these vesicles, a process known as [endocytosis](https://www.sciencedirect.com/topics/medicine-and-dentistry/endocytosis%22%20%5Co%20%22Learn%20more%20about%20Endocytosis%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages). The fates of the receptors and the molecules they carry will also be discussed.

**Keywords**

Membrane transporters

Uniport

Symport

Antiport

Active versus passive transport

Channel

Lysosome

Gradients (chemical, electrical, and electrochemical)

Nernst equation

Endocytosis

Phagocytosis

Pinocytosis

Clathrin

Endosome

Receptor fate

**Chapter 3 - Cell Growth**

**Abstract**

Cells are living things, and as such they will grow and divide in a cyclic fashion. Biotechnologists often want to harvest products that are made by cells. To maximize the amount of product that is obtained, knowledge of the [cell cycle](https://www.sciencedirect.com/topics/medicine-and-dentistry/cell-cycle%22%20%5Co%20%22Learn%20more%20about%20Cell%20Cycle%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages) is necessary for determining the best time to collect cells, to harvest cell products, or to move cells to a new growth environment.

In this chapter, we will discuss the cell cycle on the cellular level and then move to a population-based view of cell (culture) growth. Mathematics will be used to model the growth (and decline) of cell cultures, and some means by which cell numbers and cell mass are determined will be discussed.

What might work in the laboratory might not work on the industrial scale. Issues and realities of the scale-up process will be presented, along with some of the challenges they present for the biotechnologist.

**Keywords**

Cell cycle

Mitosis

Checkpoints

Growth curve

Expansion

Split

Agar plate

Colony forming unit (CFU)

Packed cell volume

Wet weight

Dry weight

Optical density

Scale-up

Specific growth rate (*μ*net)

Rate of replication (*μ*rep)

**Chapter 4 -**

**Abstract**

“Go clean your room!” Sure, we may have been told this as children, but were any of us brave enough to have asked, “How clean is clean?” Maybe you have been told, “I want this floor clean enough to eat off of it,” but even that level of cleanliness is not good enough for the surgical suite or the cell culture laboratory.

While we will not cover a way to get more items to fit under your bed, this chapter will address different levels of clean in terms of killing microbes. Starting with the Gram stain, which is a biotechnical application used to identify broad classes of microbes, we will discuss different types of microbes and their relative resistances to killing. The differences between sterilization, disinfection, sanitization, and antiseptics will be presented, and different approaches for killing microbes will be discussed in detail. While many of the methods presented will apply to the laboratory, examples of antibiotics used to treat human disease will be covered.

**Keywords**

Gram stain

Sterilization

Disinfection

Sanitization

Antiseptics

Alcohol

Antimicrobial drugs

**Chapter 5 - Fermentation, Beer, and Biofuels**

**Abstract**

Fermentation is a chemical process that has been used in biotechnological applications for thousands of years. It is used by cells that break down sugars for energy when there is no oxygen around. This chapter will begin by introducing two molecular pathways that are used by cells to gain energy from sugars. After the normal metabolic pathways have been established, alternative pathways will be addressed as fermentation itself is defined and discussed.

Fermentative pathways are used in a variety of applications ranging from the productions of beer to [biofuels](https://www.sciencedirect.com/topics/medicine-and-dentistry/biofuel%22%20%5Co%20%22Learn%20more%20about%20Biofuel%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages). Each of these applications will be addressed in detail, bringing forward the knowledge we gained from the first two units of this book.

**Keywords**

Glycolysis

Aerobic and anaerobic respiration

Fermentation

Beer

Malting

Wort

Sour mash

Raw beer

Yeast

Skunky beer

Ethanol

Biofuel

Butanol

Cellulose

Cellulase

**Chapter 6 - Biofuel Production****[∗](https://www.sciencedirect.com/science/article/pii/B9780444633576000201%22%20%5Cl%20%22fn1)**

**Abstract**

Although [vegetable oil](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/vegetable-oils) could be used directly as fuel in diesel engines, the most important limitation lies in the fact that high viscosity of vegetable oils results in poor [atomization](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/nebulization) in the engines combustion chamber which eventually leads to other operational problems. [Transesterification](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/transesterification) is a catalytic route to obtain biodiesel and the catalyst could be an acid, base in homogeneous and heterogeneous forms or by enzymatic reaction. Use of alkaline catalysts may cause side reaction such as [saponification](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/saponification) and consequently entrapment of the produced biodiesel in the produced soap. Homogeneous acid catalysts on the other hand resist to high FFA content of the feedstock and could catalyze both transesterification and [esterification](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/esterification) reactions simultaneously. Corrosion problem caused by acid catalysts as well as high oil to alcohol ratio requirement caused to depend on heterogeneous catalytic with highly preformed process.

**Keywords**

Biofuel

Bioethanol

Biobutanol

Biodiesel

Biohydrogen

Biomethane

Feedstock

Energy integration

**Chapter 7 - Fungi and Biotechnology**

**Abstract**

In our time, advances in [biotechnology](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/biotechnology%22%20%5Co%20%22Learn%20more%20about%20Biotechnology%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages) have enabled scientists to develop industrial processes for manufacturing enzymes, organic acids, vitamins, antibiotics, and a range of other pharmaceutical agents using [fungi](https://www.sciencedirect.com/topics/immunology-and-microbiology/fungus%22%20%5Co%20%22Learn%20more%20about%20Fungus%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages). The use of yeasts in [winemaking](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/winemaking%22%20%5Co%20%22Learn%20more%20about%20Winemaking%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages), [brewing](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/brewing%22%20%5Co%20%22Learn%20more%20about%20Brewing%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages) [beer](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/beers%22%20%5Co%20%22Learn%20more%20about%20Beers%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages), and baking are examples of biotechnology that began thousands of years ago. Mushroom cultivation, particularly the tradition of raising mushrooms on logs, has also been practiced for centuries. Fungi are used in the manufacture of cheeses, chocolate, and a range of [fermented foods](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/fermented-foods%22%20%5Co%20%22Learn%20more%20about%20Fermented%20Foods%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages). Technological advances in the design of [fermenters](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/fermenters%22%20%5Co%20%22Learn%20more%20about%20Fermenters%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages) for growing fungi, along with the development of methods of [genetic transformation](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/genetic-transformation%22%20%5Co%20%22Learn%20more%20about%20Genetic%20Transformation%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages) have revolutionised the business of fungal biotechnology. The use of fungi in [biofuel](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/biofuels%22%20%5Co%20%22Learn%20more%20about%20Biofuels%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages) production is an exceedingly important enterprise in an era of climate change and the recognition of its link to burning [fossil fuels](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/fossil-fuels%22%20%5Co%20%22Learn%20more%20about%20Fossil%20Fuels%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages). Fungi also show promise in the [remediation](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/remediation%22%20%5Co%20%22Learn%20more%20about%20Remediation%20from%20ScienceDirect%27s%20AI-generated%20Topic%20Pages) of habitats damaged by industrial activity, mining, and agriculture.

**Keywords**

Antibiotics

Biofuel

Bioremediation

Fermentation

Fermented foods

Genetic transformation

Mushroom cultivation

Shiitake

Single cell protein

White button mushroom