
بسم الله الرحمن الرحيم

Foundation Module
CASE BASED LEARNING (CBL)
1st Year MBBS
Body Fluid Compartment, Cell Membrane and Cytoskeleton

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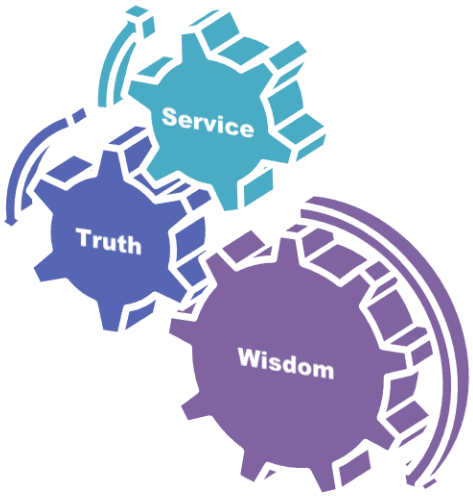
Motto



Vision; The Dream/Tomorrow

- To impart evidence based research oriented medical education
- To provide best possible patient care
- To inculcate the values of mutual respect and ethical practice of medicine

CBL

- Case-based learning (CBL) is a teaching method where students learn by analyzing real-life cases and applying their knowledge to solve problems or make decisions. CBL is often used in medical education, where students analyze patient cases to develop diagnostic and treatment skills.

Conducting CBL

- Identify the learning objectives
- Choose a case: Select a real-life case that is relevant to the learning objectives you have identified
- Present the case
- Analyze the case: Have students work in groups to analyze the case
- Develop hypotheses

Conducting CBL (Cont.)

- Test hypotheses: Have students test their hypotheses by using relevant diagnostic tests or other methods.
- Discuss the results
- Discuss the results
- Evaluate learning: Evaluate student learning by assessing their ability to analyze the case, develop hypotheses, and apply their knowledge of medical physiology to diagnose and treat the patient.

Bloom's Taxonomy : Domains Of Learning

Sr. #	Domain of learning	Abbreviation	Levels of the domain	Meaning
1	cognition	C	C1	Recall / Remembering
2			C2	Understanding
3			C3	Applying / Problem solving
4	Psychomotor	P	P1	Imitation / copying
5			P2	Manipulation / Follows instructions
6			P3	Precision / Can perform accurately
7	Attitude	A	A1	Receiving / Learning
8			A2	Respond / Starts responding to the learned attitude
9			A3	Valuing / starts behaving according to the learned attitude

Learning Objectives

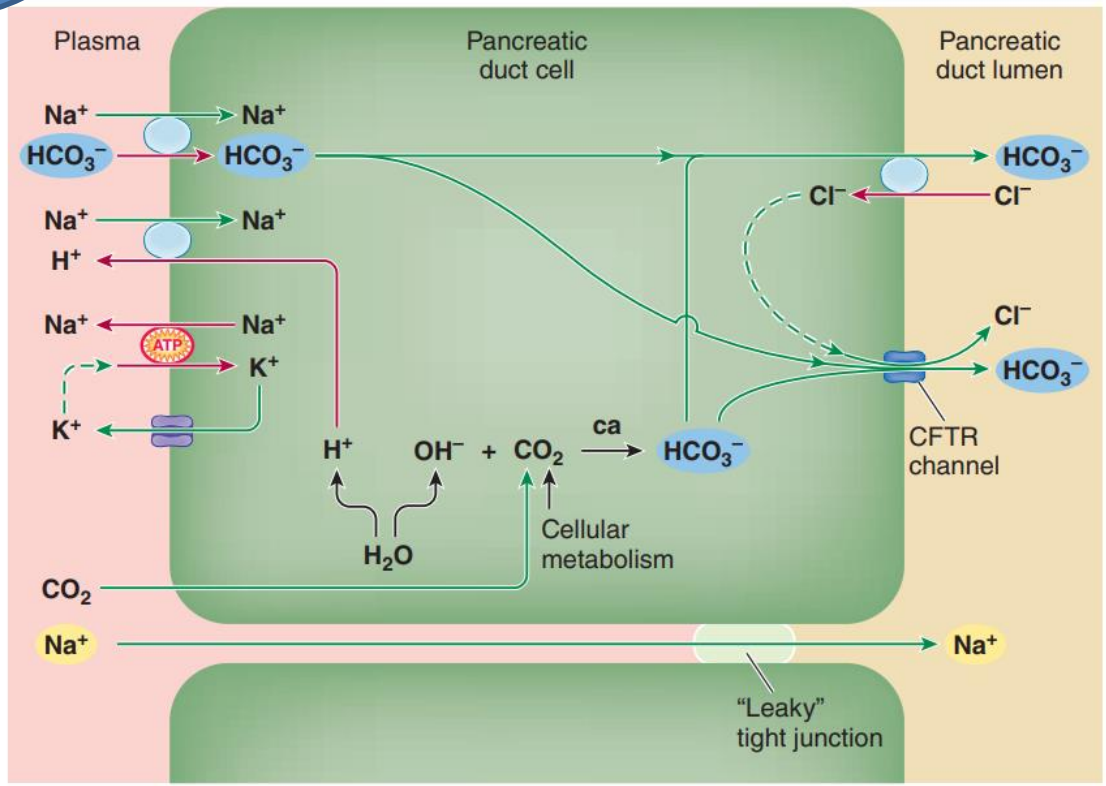
Sr. #	Learning Objective	Domain of Learning
1	To recall the structure of cell membrane and cystoskeleton	C1
2	To describe respiratory and pancreatic problems due to cystic fibrosis	C2
3	To understand the channelopathy behind cystic fibrosis	C2
4	To investigate and treat the patient of cystic fibrosis	C3
5	To understand the pathophysiology behind ALS	C3
7	To assess clinical signs and symptoms of cystic fibrosis	C3

Cystic Fibrosis

Cystic Fibrosis is characterized by the production of abnormally thick, sticky mucus. Most dramatically affected are the respiratory airways and the pancreas.

Underlying cause

- Genetic mutation in CFTR gene
- CFTR gene mutation leads to flawed protein production.
- Defective CFTR proteins fail to form chloride channels in the plasma membrane.
- Result: Impaired chloride ion transport across cell membranes.



KEY

- = Active transport
- = Secondary active transport
- ca = Carbonic anhydrase
- CFTR = Cystic fibrosis transmembrane conductance regulator protein
- = Passive diffusion
- = Chemical reaction

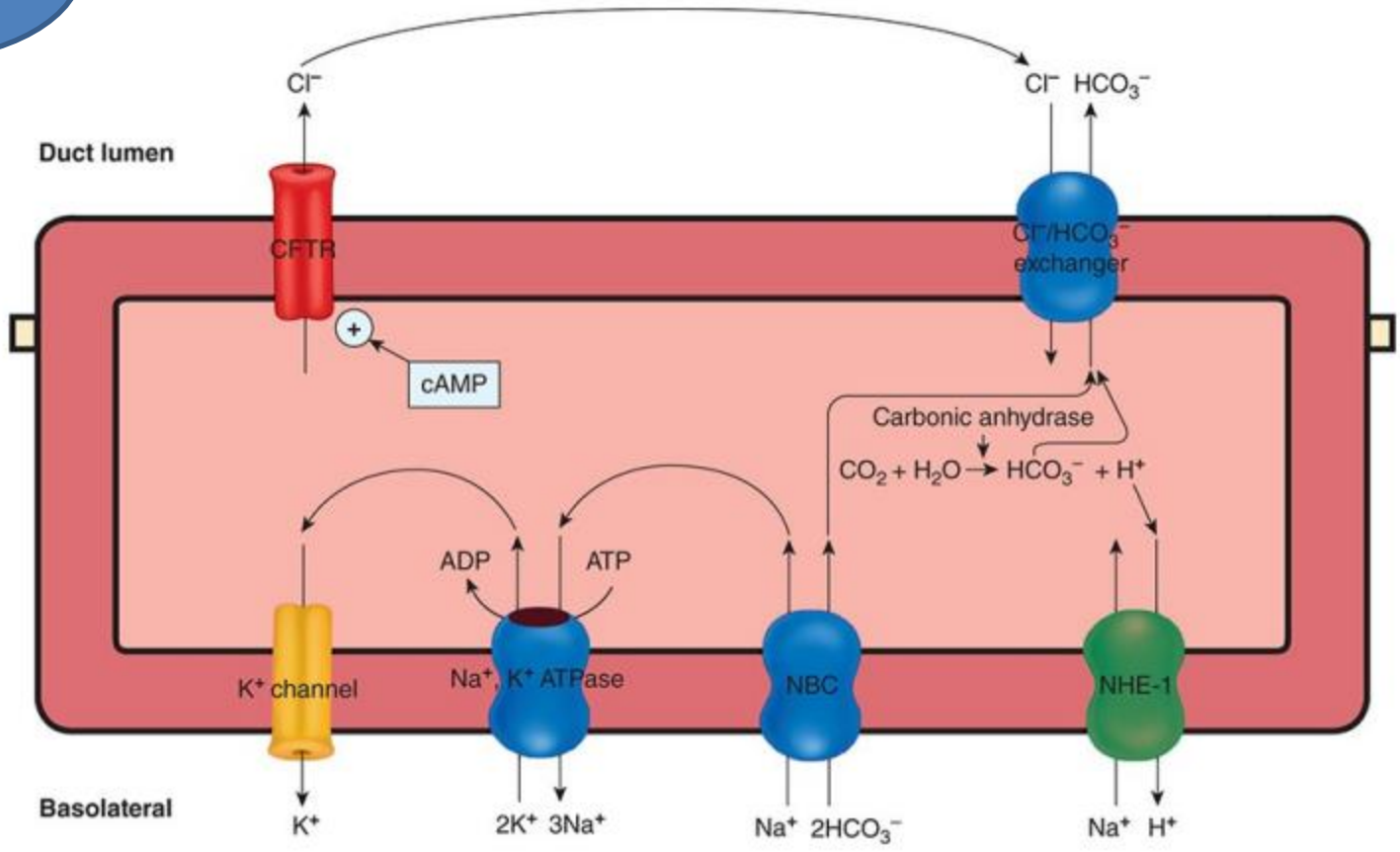


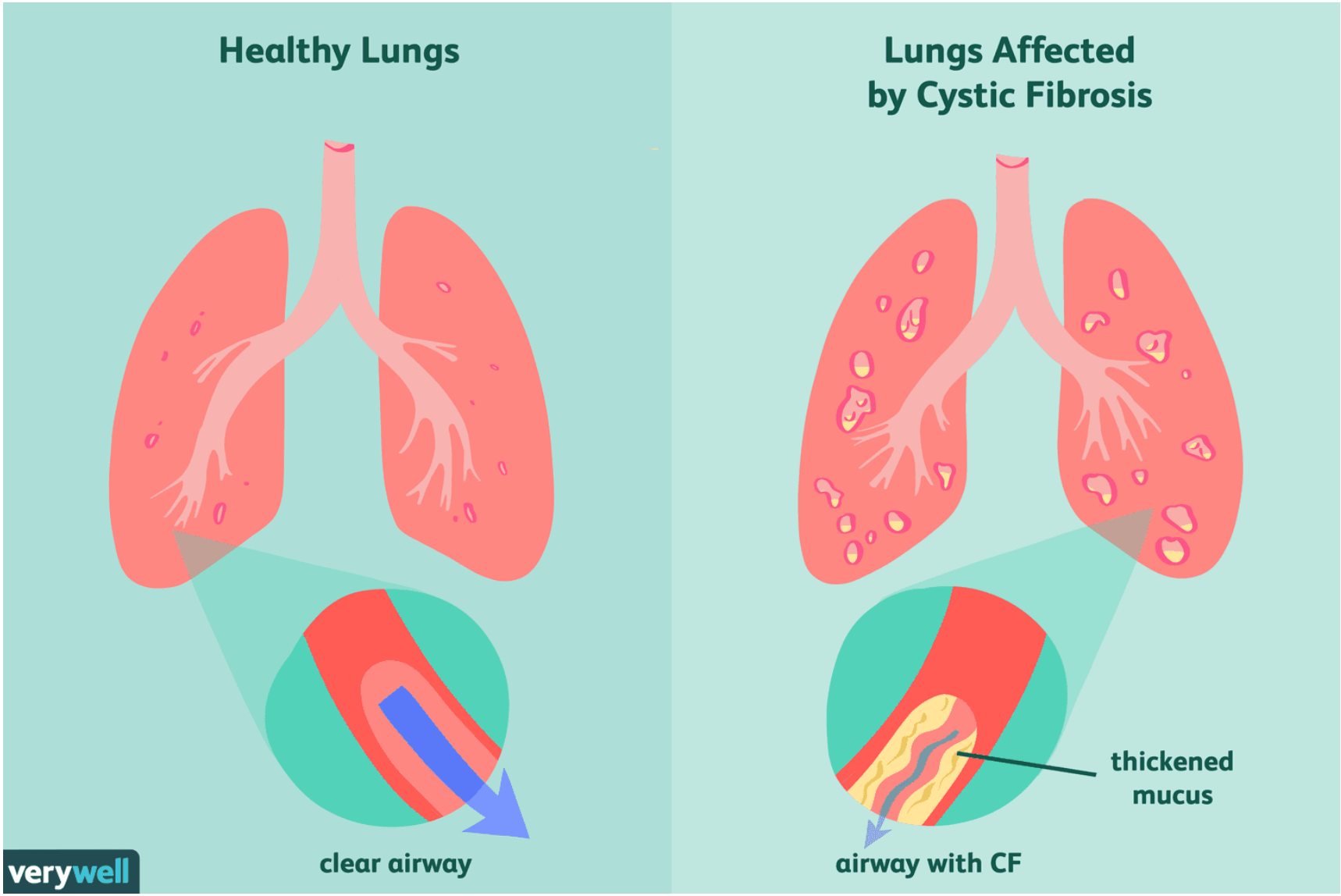
FIGURE 25–14 Ion transport pathways present in pancreatic duct cells. CFTR, cystic fibrosis transmembrane conductance regulator; NHE-1, sodium/hydrogen exchanger-1; NBC, sodium-bicarbonate cotransporter.

Characteristics

- Sodium chloride accumulation in airway fluid due to impaired transport.
- Salt-rich environment hinders the function of natural antibiotics.
- Reduced effectiveness of white blood cells against infections.
- Excessive production of thick, sticky mucus in the airways.

Respiratory problems

- Thick mucus in airways obstructs airflow.
- Promotes bacterial growth, leading to recurrent infections.
- Vulnerability to Pseudomonas aeruginosa.
- Scarred lung tissue (fibrosis) complicates breathing.



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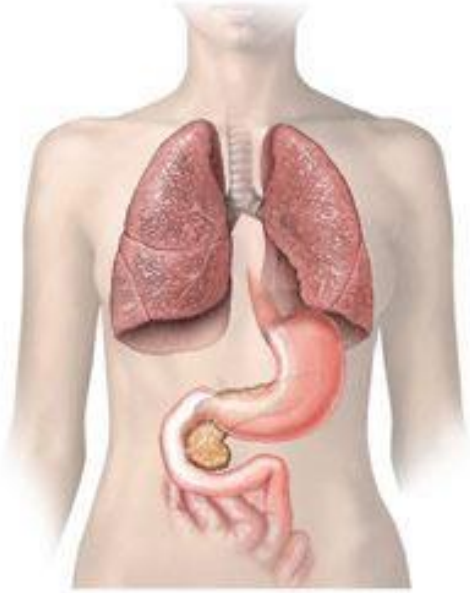
Pancreatic Problems

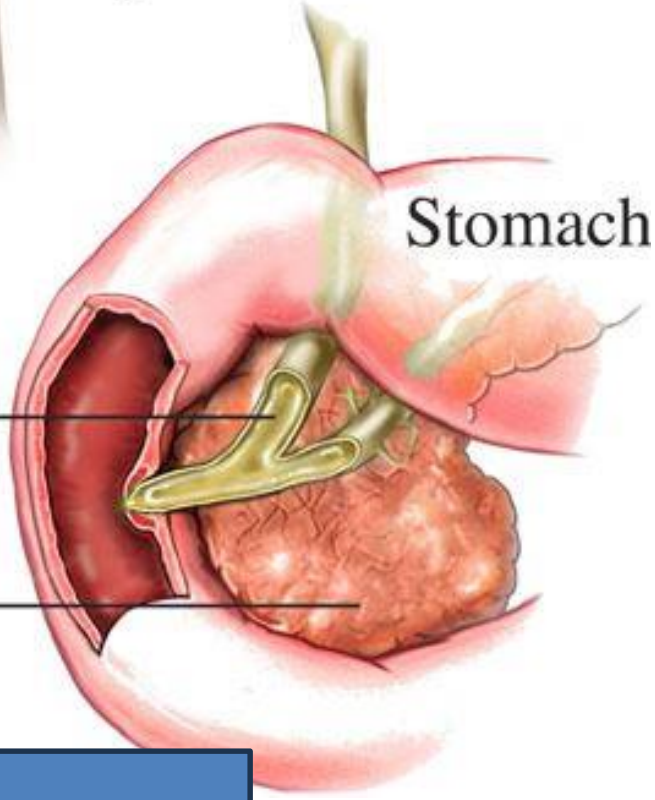
- Pancreatic duct blockage by mucus.
- Impairs enzyme secretion and digestion.
- Malnourishment and pancreatic tissue degeneration.
- Formation of fluid-filled cysts in the pancreas.

Cystic Fibrosis

Mucus blocks air sacs (alveoli) in the lungs



Mucus blocks pancreatic ducts



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Signs and Symptoms

- Chronic cough with thick mucus.
- Frequent lung infections.
- Shortness of breath.
- Poor weight gain despite good appetite.
- Bulky, greasy stool
- Salty taste of skin
- Dehydration
- Clubbing of hands

Investigations

1. **Sweat Chloride Test**:

   Measures chloride levels in sweat (>60 mmol/L indicates CF).

2. **Genetic Testing**:

   Identifies CFTR gene mutations.

3. **Newborn Screening**:

   Detects elevated immunoreactive trypsinogen (IRT) levels.

4. **Pulmonary Function Tests (PFTs):**

   Evaluates lung function.

Treatment

- Physical therapy and mucus-thinning aerosols to clear airways.
- Antibiotic therapy for respiratory infections.
- Special diets and pancreatic enzyme supplements for nutrition.
- Despite treatment, life expectancy limited, often not beyond late 30s.

Structure of The cell Membrane

- Basic structure is a lipid bilayer interspersed with large globular proteins
- The basic lipid bilayer is composed of three main types of lipids—phospholipids, sphingolipids, and cholesterol.

- The phosphate end of each phospholipid molecule is hydrophilic and soluble in water.

- The fatty acid portion is hydrophobic and soluble only in fats

Horizontal Integration with anatomy

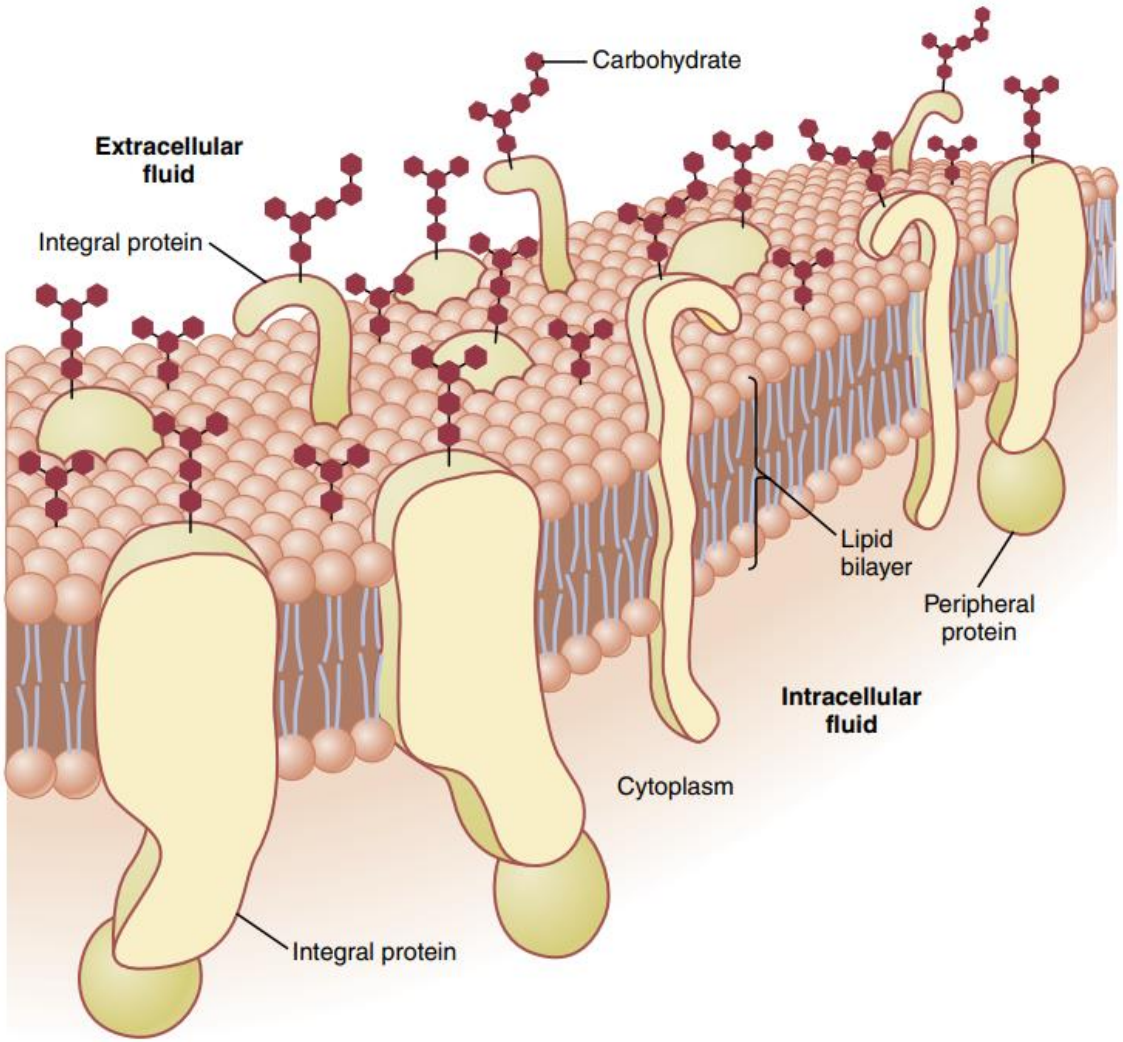


Figure 2-3. Structure of the cell membrane showing that it is composed mainly of a lipid bilayer of phospholipid molecules, but with large numbers of protein molecules protruding through the layer. Also, carbohydrate moieties are attached to the protein molecules on the outside of the membrane and to additional protein molecules on the inside.

Reference : Guyton and Hall Textbook of Physiology Fourteen edition page 15

Cell membrane proteins

- Types of cell membrane proteins

1. integral proteins, which protrude all the way through the membrane
2. peripheral proteins, which are attached only to one surface of the membrane and do not penetrate all the way through

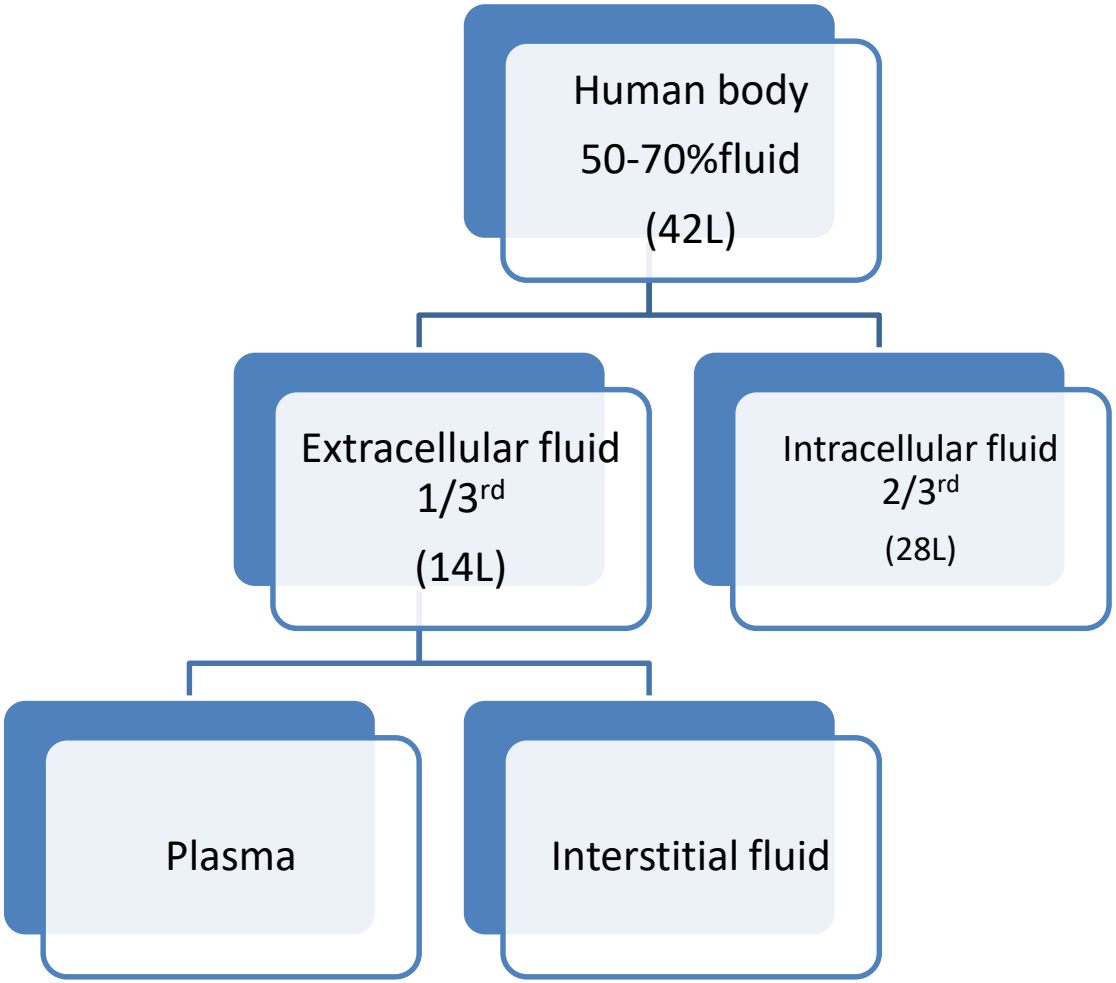
- **Integral proteins**

Act as **channels**(pores), receptors, carrier proteins

- **Peripheral proteins**

Attached to integral proteins act as enzymes and as controllers of transport of substances through cell membrane pores.

Body Fluid Compartments



Difference Between Extracellular And Intracellular Fluid

Extracellular fluid	**Intracellular fluid**
•Found outside the cells	•Found inside the cells
•1/3rd of total body fluid	•2/3rd of total body fluid
•Major cation is sodium	•Major cation is potassium
•Major anion is chloride	•Major anion is phosphate

Amyotropic Lateral Sclerosis

Amyotrophic lateral sclerosis (ALS)

- abnormal accumulation and disorganization of neurofilament(intermediate filaments)
- Disorganized neurofilaments block the axonal transport of crucial materials along the microtubular highways, thus choking off vital supplies from the cell body to the axon terminal

Amyotrophic lateral sclerosis (ALS)

- progressive degeneration and death of motor neurons, the type of nerve cells that control skeletal muscles.
- gradual loss of control of skeletal muscles, including the muscles of breathing, and ultimately to death

Cell Cytoskeleton

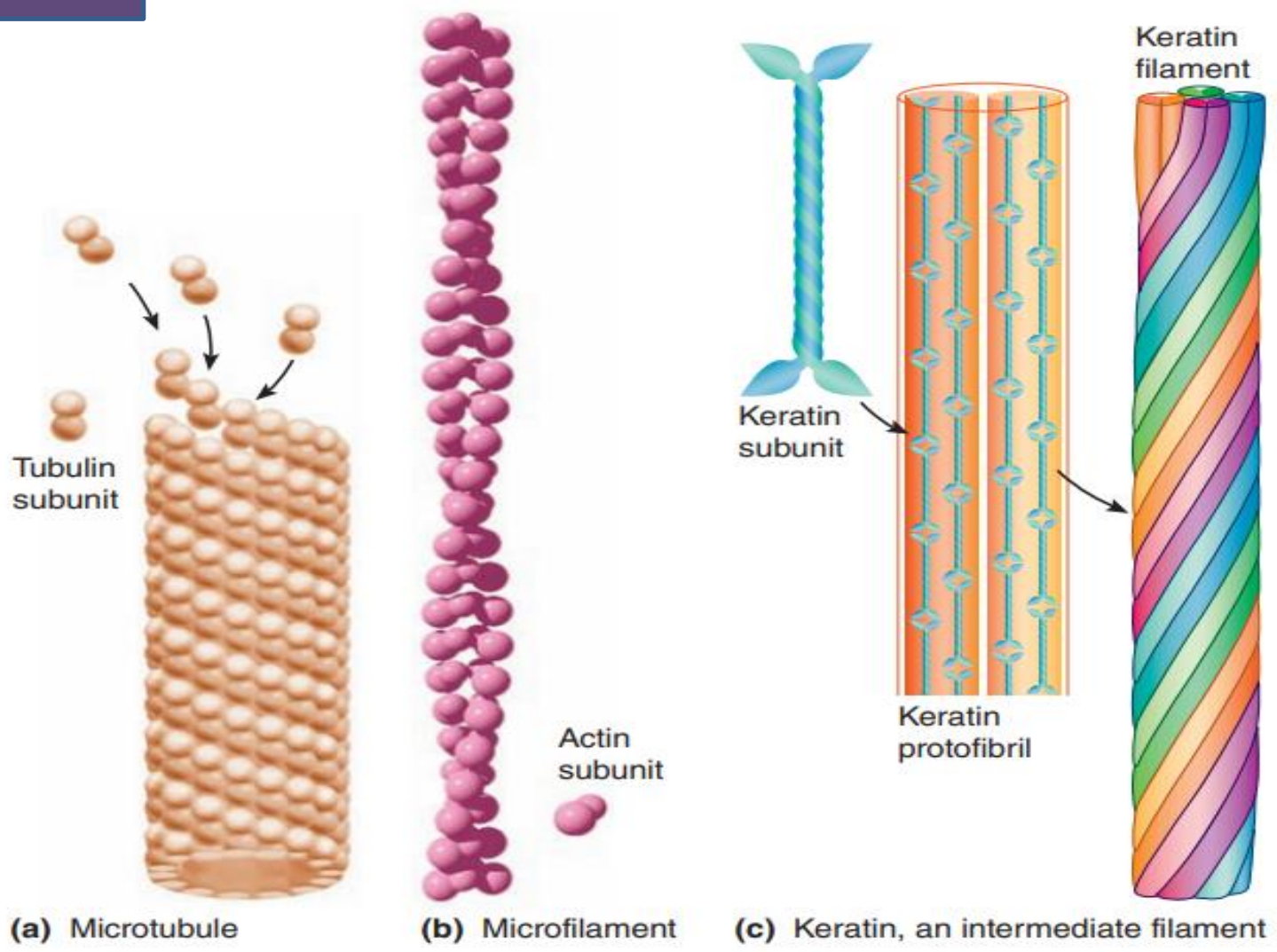
- It is a network of fibrillar proteins organized into filaments and tubules, dispersed throughout the cytosol that acts as the “bone and muscle” of the cell by supporting and organizing the cell components and controlling their movements

- Types of cytoskeletal elements :

1. microtubules,
2. microfilaments
3. intermediate filaments

Microtubules	Long, slender, hollow tubes composed of tubulin molecules	Maintain asymmetric cell shapes and coordinate complex cell movements, specifically serving as highways for transport of secretory vesicles within cell, serving as main structural and functional component of cilia and flagella, and assembling into mitotic spindle
Microfilaments	Intertwined helical chains of actin molecules; microfilaments composed of myosin molecules also present in muscle cells	Play a vital role in various cellular contractile systems, including muscle contraction and amoeboid movement; serve as a mechanical stiffener for microvilli
Intermediate filaments	Irregular, threadlike proteins	Help resist mechanical stress

Reference : Sherwood 9th edition page 45



Reference : Sherwood 9th edition page 46

Case Study/ Brain Storming/ Vertical Integration with Internal Medicine

Brain Storming

A 7-year-old male presented to OPD with his parents who were concerned about their son's health and repeated chest infections. After history,examination and relevant investigations he is diagnosed with Cystic Fibrosis

Brain Storming

Question Related to Scenario

Question 1 : . Which ion channel is defective in this disease

- Answer :

Chloride Channels

Brain Storming

Question Related to Scenario

Question 2 : What are the respiratory problems that could occur in a patient with Cystic Fibrosis

Answer

- The presence of thick, sticky mucus in the respiratory airways makes it difficult to get adequate air in and out of the lungs.
- bacteria thrive in the accumulated mucus, patients with CF experience repeated respiratory infections.
- They are especially susceptible to Pseudomonas aeruginosa, an “opportunistic” bacterium that is often present in the environment but usually causes infection only when some underlying problem handicaps the body’s defenses.
- Gradually, the involved lung tissue becomes scarred (fibrotic), making the lungs harder to inflate. This complication increases the work of breathing beyond the extra effort required to move air through the clogged airways

Question Related to Scenario

Question 3 :What is the pathophysiology behind cystic fibrosis

Answer

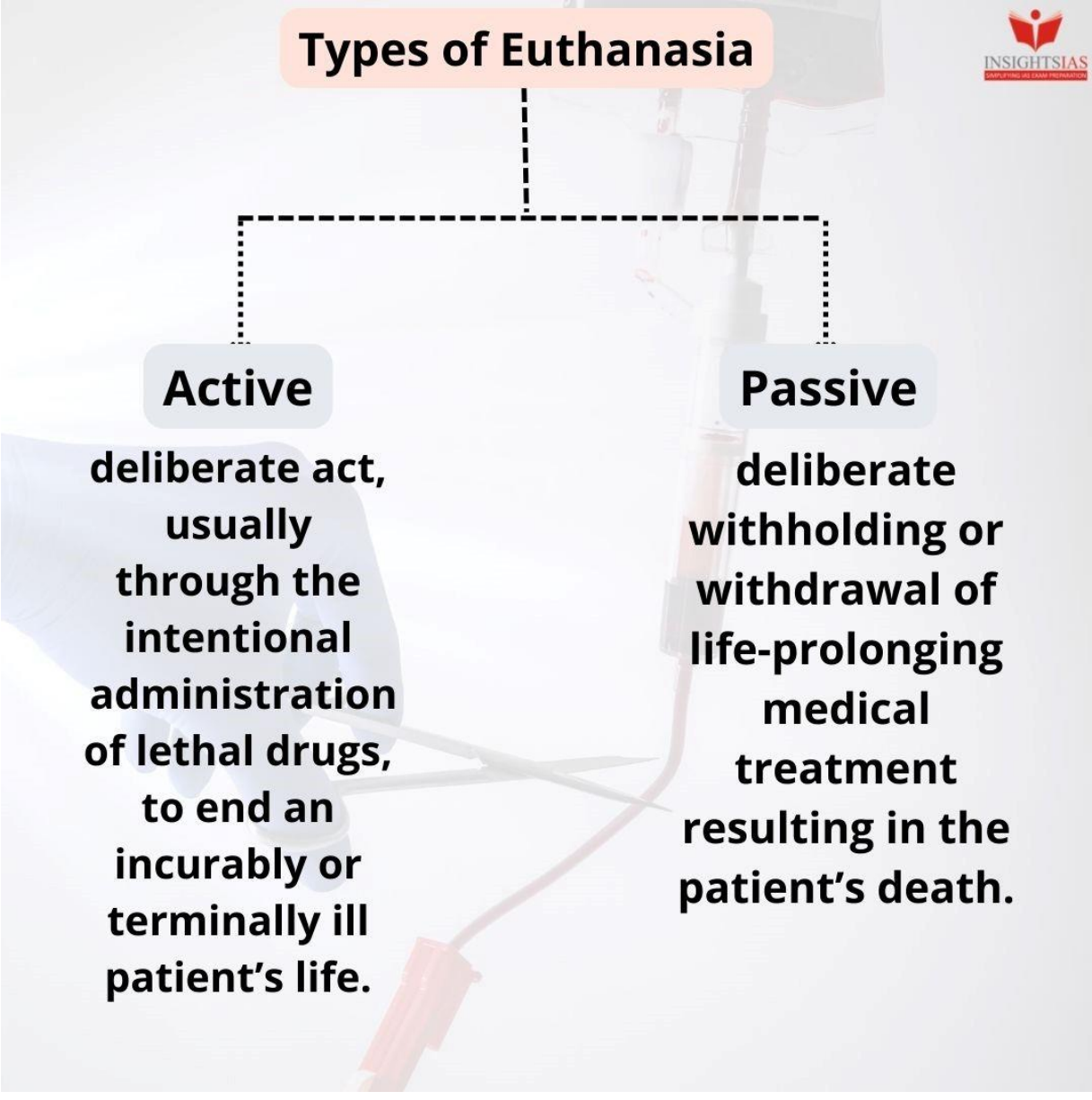
- Genetic mutation in CFTR gene
- CFTR gene mutation leads to flawed protein production.
- Defective CFTR proteins fail to form chloride channels in the plasma membrane.
- Result: Impaired chloride ion transport across cell membranes.
- Sodium chloride accumulation in airway fluid due to impaired transport.
- Salt-rich environment hinders the function of natural antibiotics.
- Reduced effectiveness of white blood cells against infections.
- Excessive production of thick, sticky mucus in the airways

Biomedical Ethics

Euthanasia:-

The term “Euthanasia” is derived from Greek, literally meaning **“good death”.** taken in its common usage, however, euthanasia refers to the **Termination of a person’s life, to end their suffering, usually from an incurable or terminal condition**. it is for this reason that euthanasia was also coined the name **“Mercy Killing”.**

EUTHANASIA:-


Types of Euthanasia
INSIGHTSIAS
Active
deliberate act, usually through the intentional administration of lethal drugs, to end an incurably or terminally ill patient's life.
Passive
deliberate withholding or withdrawal of life-prolonging medical treatment resulting in the patient's death.

RELATED RESEARCH ARTICLE

J Cyst Fibros. 2022 May;21(3):456-462. doi: 10.1016/j.jcf.2022.01.009. Epub 2022 Feb 4.

Worldwide rates of diagnosis and effective treatment for cystic fibrosis

Jonathan Guo [1], Anna Garratt [2], Andrew Hill [3]

Affiliations + expand

PMID: 35125294 DOI: 10.1016/j.jcf.2022.01.009

Free article

Abstract

Background: Time has seen management for Cystic Fibrosis (CF) advance drastically, most recently in the development of the disease-modifying triple combination therapy ivacaftor/tezacaftor/elexacaftor. There is currently limited evidence regarding both the global epidemiology of CF and access to this transformative therapy - and therefore where needs are not being met. Therefore, this study aims to define gaps in access to CF treatment.

Methods: Patient data were extracted from established CF registries. Where these were not available, literature searches were conducted alongside an international survey of 51 CF experts to determine the diagnosed patient population. National CF prevalence estimates were combined with registry data on estimated population coverage, to extrapolate the total estimated number of undiagnosed patients. Estimates of ivacaftor/tezacaftor/elexacaftor treatment coverage were extracted from publicly available sales summaries and pricing data.

Results: 162,428 [144,606-186,620] people are estimated to be living with CF across 94 countries. Of these, an estimated 105,352 (65%) are diagnosed, with 19,516 (12%) receiving triple combination therapy. We estimated 57,076 patients with undiagnosed CF. Owing to a paucity of high-quality data, estimates of undiagnosed CF in low- and middle-income countries are highly uncertain. Patient registries were available in 45 countries, and used to identify 90% of the estimated diagnosed population.

Summary of the research article

- significant CF patient burden exists in countries where disease-modifying drugs are unavailable, and final figures are likely underestimates. This analysis shows the potential to improve rates of diagnosis and treatment for CF, so a higher percentage of patients receive the most effective triple combination treatment.

Take home message

- Define cystic fibrosis
- Underlying channelopathy
- Signs and symptoms related to respiratory and pancreatic system
- Investigations and treatment for cystic fibrosis

REFERENCE BOOKS:

Guyton And Hall textbook of Medical Physiology 14th Edition.

Davidson's Principles and Practice of Medicine - 24th Edition

Oxford Handbook of Clinical Medicine

Research Article Link:-

Worldwide rates of diagnosis and effective treatment for cystic fibrosis - PubMed (nih.gov)
/ pubmed.ncbi.nlm.nih.gov/35125294/

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Thank You!