Role of Metabolism in Cancer

An Introduction to the Basics

Outline

1. What is Cancer?
2. Normal Cell Metabolism
3. Why Cancer Alters Metabolism
4. Importance in Medicine

What is Cancer?

A disease of uncontrolled growth and division of abnormal cells, caused by genetic mutations in **oncogenes** & **tumor suppressor genes**.

Hallmarks of Cancer (Hanahan & Weinberg):

- Sustained proliferation
- Evasion of apoptosis (programmed cell death)
- Induction of angiogenesis (new blood vessels)
- Invasion & metastasis
- **Altered metabolism**

Cancer cells need a **continuous supply of energy** and building blocks for growth.

Normal Cell Metabolism

Glucose Metabolism Pathway:

Glycolysis → Pyruvate → TCA Cycle → Oxidative Phosphorylation

Produces **~36 ATP** per glucose (efficient but oxygen-dependent).

Mitochondria

The powerhouse of the cell, where the TCA cycle and oxidative phosphorylation occur.

Metabolism Balances:

- ATP production (energy)
- Biomolecule synthesis (building blocks)

Normal cells adjust metabolism based on **energy needs & oxygen availability.**

Why Cancer Alters Metabolism

Rapid proliferation creates a higher demand for nutrients and energy.

The tumor microenvironment is often **hypoxic** (low oxygen).

The Warburg Effect

Cancer cells shift to **aerobic glycolysis**. Though less efficient for ATP, this process is much faster.

Glycolysis Provides Intermediates for:

- **Nucleotide synthesis** (for DNA/RNA)
- **Amino acid synthesis** (for proteins)
- **Lipid synthesis** (for cell membranes)

Altered metabolism supports cancer growth, survival, and invasion.

Importance in Medicine

Diagnostic Applications

PET imaging detects increased glucose uptake in tumors, helping to locate and stage cancer.

Therapeutic Applications

Developing drugs that target key metabolic pathways like **glycolysis** or **glutamine metabolism**.

Research Applications

Helps us understand tumor biology and links biochemistry to clinical oncology.

Key Point: Altered metabolism is both a hallmark and a therapeutic target in cancer.