ABERRANT CELL GROWTH

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Objectives

By the end of this session the learners will be able to,

• Define the characteristics of the normal cell
• Describe the characteristics if the cancer cells
• Discuss the predisposing factors of the aberrant cell growth
• Differentiate between malignant and benign tumor
• Describe the TNM system
• Explain proto oncogene and anti oncogene
NORMAL CELL

• Cells are the smallest functional unit of the body
• They contain structures that are strikingly similar to those needed to maintain total body function
• The nucleus is the control center for the cell. It also contains most of the hereditary material.
• The organelles, which are analogous to the organs of the body, are contained in the cytoplasm.
• The cell membrane encloses the cell and provides for intracellular and intercellular communication, transport of materials into and out of the cell.
CHARACTERISTICS OF THE NORMAL CELL

• Normal body cells have a number of important characteristics.
• They can Reproduce themselves exactly
• Stop reproducing at the right time
• There is proper cell communication in between the cells
• Stick together in the right place
• Self destruct if they are damaged
• Become specialized or 'mature
NORMAL CELL CYCLE

G1 - Growth
S - DNA synthesis
G2 - Growth and preparation for mitosis
M - Mitosis (cell division)

S
Each of the 46 chromosomes is duplicated by the cell.

G1
Cellular contents, excluding the chromosomes, are duplicated.

G2
The cell "double checks" the duplicated chromosomes for error, making any needed repairs.

G0
Cell cycle arrest.
NORMAL CELL CYCLE

• G0, non dividing cell
• G1, cell growth; S, DNA replication;
• G2, protein synthesis; and mitosis, which lasts for 1 to 3 hours and is followed by cytokinesis or cell division.
• T, telophase
• A, anaphase
• M, metaphase
• P, prophase
CANCER CELLS

Cancer (Neoplasia)

- Cancer is a disorder of altered cell differentiation and growth. The resulting process is called *neoplasia*, meaning “new growth,” and the new growth is called a *neoplasm*.
CHARACTERISTICS OF THE CANCER CELLS

- Cancer cells are different to normal cells in several ways. They don't die if they move to another part of the body and
- Cancer cells don't stop reproducing (Unlike normal cells, cancer cells do not stop reproducing after they have doubled 50 or 60 times).
- Cancer cells don't obey signals from other cells (Something in the cancer cells overrides the normal signaling system. This may be because the genes that tell the cell to reproduce keep on and on firing. Or because the genes that normally tell the cell to stop reproducing have been damaged or lost. So the cancer cell keeps on doubling, regardless of the damage the extra cells cause to the part of the body where the cancer is growing).
- Cancer cells don't stick together
- Cancer cells don't specialize, but stay immature
Normal Tissue renewal

• Normal tissue renewal and repair involves cell proliferation, differentiation, and apoptosis

**PROLIFERATION**

• Proliferation, or the process of cell division, is an inherent adaptive mechanism for cell replacement when old cells die or additional cells are needed.

• Cell proliferation is the process of increasing cell numbers by mitotic cell division. In normal tissue, cell proliferation is regulated so that the number of cells actively dividing is equivalent to the number dying or being shed.
**PROLIFERATION**

- In humans, there are two major categories of cells: gametes and somatic cells.

**APOPTOSIS**

- Apoptosis is a form of programmed cell death that eliminates senescent cells, cells with damaged DNA, or unwanted cells.
Cell Differentiation

- Cell differentiation is the process whereby proliferating cells become progressively more specialized cell types. This process results in a fully differentiated, adult cell that has a specific set of structural, functional, and life expectancy characteristics.

- For example, the red blood cell is a terminally differentiated cell that has been programmed to develop into a concave disk that functions as a vehicle for oxygen transport and lives approximately 120 days.
DIFFERENTIATION

Body cells can be divided into two large groups:

• The well differentiated neurons and cells of skeletal and cardiac muscle that rarely divide and reproduce,

• Second is the progenitor or parent cells that continue to divide and reproduce, such as blood cells, skin cells, and liver cells.

• A third category of cells are the stem cells that remain quiescent until there is a need for cell replenishment, in which case they divide, producing other stem cells and cells that can carry out the functions of differentiated cells.
DIFFERENTIATION

• Cells can be well differentiated, moderately differentiated, or poorly differentiated

  Grade of the cancer cell

• The more normal a cancer cell looks, the lower its grade,

• The more abnormal or less well developed a cancer cell is, the higher its grade

• Low, medium or high grade. It is also called grades 1, 2, or 3, where grade 1 is low grade.
TUMORS

• Tumor is a swelling that can be caused by a number of conditions, including inflammation and trauma, but more recently the term has been used to define a mass of cells that arises because of overgrowth.
• Although not synonymous, the terms tumor and neoplasm often are used interchangeably.

TUMOR GROWTH

• Once cells have an adequate blood supply, the rate of tissue growth in normal and cancerous tissue depends on three factors:
  (1) the number of cells that are actively dividing or moving through the cell cycle,
  (2) the duration of the cell cycle, and
  (3) the number of cells that are being lost relative to the number of new cells being produced.

One of the reasons cancerous tumors often seem to grow so rapidly relates to the size of the cell pool that is actively engaged in cycling.
CLASSIFICATION OF THE TUMOR

• Tumors are classified as follows
  • Malignant
  • Benign

PROCERTIES OF THE BENIGN TUMOR

• Benign neoplasms are well-differentiated tumors
• These resemble the tissues of origin
• These have loss of control of cell proliferation.
• They grow by expansion,
• These are enclosed in a fibrous capsule,
• and do not cause death unless their location is such that it interrupts vital body functions.
CLASSIFICATION OF THE TUMORS

PROPERTIES OF THE MALIGNANT TUMORS

• These are less well-differentiated
• These have lost the ability to control both cell proliferation and differentiation.
• They grow in a disorganized and uncontrolled manner to invade surrounding tissues,
• These have cells that break loose and travel to distant sites to form metastases,
• And inevitably cause suffering and death unless their growth can be controlled through treatment.
Carcinogenesis

- The process by which carcinogenic (cancer-causing) agents cause normal cells to become cancer cells is hypothesized to be a multistep mechanism that can be divided into three stages:
  - **Initiation**: (involves the exposure of cells to appropriate doses of a carcinogenic agent that makes them susceptible to malignant transformation.)
  - **Promotion**: (involves the induction of unregulated accelerated growth in already initiated cells by various chemicals and growth factors. Promotion is reversible if the promoter substance is removed)
  - **Progression**: (the process whereby tumor cells acquire malignant phenotypic changes that promote invasiveness, metastatic competence, autonomous growth tendencies, and increased karyotypic instability)
Carcinogenesis

There are following predisposing factors,

- **Heredity** (A hereditary predisposition to approximately 50 types of cancer has been observed in families. Breast cancer, for example, occurs more frequently in women whose grandmothers, mothers, aunts, or sisters also have experienced a breast malignancy)

- **Hormones** (Hormones have received considerable research attention with respect to cancer of the breast, ovary, and endometrium in women and of the prostate and testis in men)

- **Immunological mechanisms** (There is substantial evidence for the immune system’s participation in resistance against the progression and spread of cancer. The central concept, known as the *immune surveillance hypothesis*)
Carcinogenesis

- **Chemical agents** (chemical carcinogens can be divided into two groups)
  1. direct-reacting agents, which do not require activation in the body to become carcinogenic.
  2. indirect-reacting agents, called procarcinogens or initiators, which become active only after metabolic conversion.

- **Radiations** (The effects of ionizing radiation in carcinogenesis have been well documented in atomic bomb survivors, in patients diagnostically exposed, and in industrial workers, scientists, and physicians who were exposed during employment).
Proto oncogenes are a group of genes that cause normal cells to become cancerous when they are mutated. (Adamson, 1987; Weinstein & Joe, 2006)

- Mutations in proto-oncogenes are typically dominant in nature,
- Mutated version of a proto-oncogene is called an oncogene.
- Often, proto-oncogenes encode proteins that function to stimulate cell division, inhibit cell differentiation, and halt cell death.
- All of these processes are important for normal human development and for the maintenance of tissues and organs.
ONCOGENES

• **ONCOGENES**, however, typically exhibit increased production of these proteins,
• Thus leading to increased cell division, decreased cell differentiation, and inhibition of cell death; taken together, these phenotypes define cancer cells.
• Thus, oncogenes are currently a major molecular target for anti-cancer drug design.
**TNM STAGING SYSTEM**

- It is the system that classifies the various cancers into different anatomical forms, its regional lymph node involvement and distant metastasis.
- **T**: It is defined as the size of the primary tumor
- **N**: It tells the presence or absence of the tumor in the regional lymph nodes and lymph node drainage.
- **M**: It is the absence or presence to the distant spread or metastasis.
TNM STAGING SYSTEM

“T” Primary tumor:

T0: No evidence of primary tumor
T.is: Carcinoma in situ
T1: Tumor < 2mm
T2: Tumor >20 mm but less than 50mm
T3: > 50mm
T4: tumor of any size /to the chest wall or skin
Tx: Primary tumor can not be assessed
TNM STAGING SYSTEM

“N” Regional lymph nodes

N₀: no regional lymph nodes involvement
N₁: Movable level (axiliary involvement)
N₂: Mammary lymph nodes, (not palpable axillary)
N₃: additionally supraclavical lymph nodes are involved
Nx: can not be assessed
TNM STAGING SYSTEM

“M” Distant Metastasis

**Mo**: No distant metastasis

**M1**: Metastasis present
REFERENCES

