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Review Article

Heterocyclic Compounds : A Key to Unlocking Cancer Treatment

Anup Kumar Patra*, Basanta Kumar Behera

College of Pharmaceutical Sciences, Puri

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ABSTRACT

Cancer is a heterogeneous group of diseases induced by various etiological agents, including chemical compounds and radiation. It consists of a variety of diseases defined by the unregulated growth and dissemination of abnormal cells. There are various anticancer agents which contain heterocyclic moiety like imidiazole, pyridine. Pteridine etc. The cause of cancer is tabaco, sun and radio light, die, alcohol, pollution, food additives, infection. Cancer formation appears by the mutation of normal gene and abnormal gene which undergoes cell division process to form cancer cell. Chemotherapy involves the administration of pharmacological agents aimed at targeting and suppressing the proliferation of malignant cells. Cancer is various type i.e . carcinoma, leukoma, sarcoma, lymphoma, melanoma. Various advance techniques used in the treatment of cancer. Those are hormone therapy, gene therapy, Radiotherapy and chemotherapy. Some anticancer agents like axitinib, tamoxifen, cytarabine, palifermin, carmustine, cyclophosphamide.

INTRODUCTION

Heterocyclic compounds are integral to the metabolic processes of all living cells. A significant proportion of these compounds consist of five- and six-membered rings, containing one to three heteroatoms within their structure. There are various type of hetero cyclic compound used in preparation of medicine like furan, imidazole pteridine, purine etc. Heterocycles are a central focus in organic chemistry, with increasing research interest driven by their valuable applications in medicine, antimicrobial agents, and numerous industrial processes [1-3].Heterocyclic compounds, known for their physiological and pharmacological activity, have become a major focus in medicinal research [4].

***Corresponding Author:** Anup Kumar Patra
Address: *College of Pharmaceutical Sciences, Puri*
Email : anupkumarpatra@cpspuri.com
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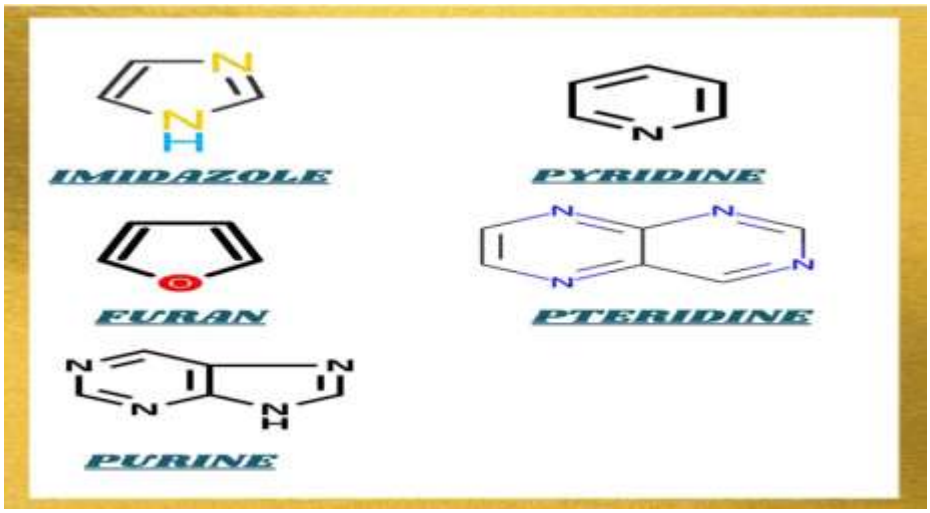
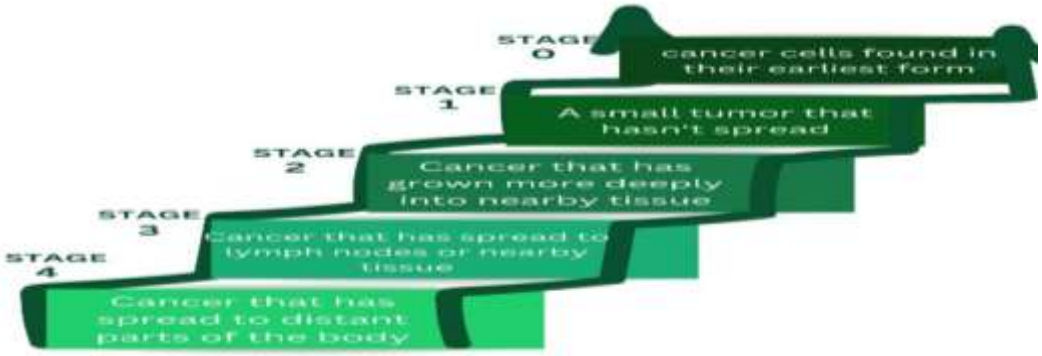


Cancer is a heterogeneous group of diseases induced by various etiological agents, including chemical compounds and radiation. It is characterized by dysregulated and uncontrolled cellular proliferation, which manifests in varying degrees of malignancy. This aberrant cell division leads to tumor formation.Tumors composed of malignant cells progressively acquire greater aggressiveness over time. They become fatal when they invade and damage critical tissues and organs essential for the overall survival of the organism [5].Cancer consists of a variety of diseases defined by the unregulated growth and dissemination of abnormal cells [6].

Chemotherapy involves the administration of pharmacological agents aimed at targeting and suppressing the proliferation of malignant cells. These therapeutic agents function by inhibiting cellular division and inducing apoptosis in cancerous tissues, leading to the reduction or elimination of tumors. Additionally, chemotherapy plays a critical role in reducing the risk of metastasis and recurrence, thereby contributing to long-term cancer management and prevention.

Various stage of cancer



Types of cancer

1. Carcinoma
2. Leukomia
3. Sarcoma
4. Lymphomas
5. melanoma

Carcinoma:

Carcinoma arises from epithelial cells, which constitute the protective lining of organs and body cavities. This form of cancer develops when these epithelial cells undergo genetic mutations, leading to uncontrolled proliferation and the potential for local invasion and metastasis to distant tissues.

Types of Carcinomas:

Carcinoma are generally four types:

- Adeno carcinoma
- Basal cell carcinoma
- Squamous cell carcinoma
- Transitional cell carcinoma

Adeno Carcinoma

It is the type of cancer which originates in the glandular epithelial cell that line inside the internal organs. This carcinoma starts from organs like large intestine, esophagus, breasts, pancreas, lungs etc.

Organs	Location
Breasts	This carcinoma originates in the milk-producing glands of the breast.
Esophagus	This carcinoma originates in the milk-producing glands of the breast
Pancreas	This carcinoma is typically found in the outer region of lungs primarily affecting individual who smokes regularly
Lungs	This carcinoma originates ducts of pancreas

Basal Cell Carcinoma

It is a type of skin cancer that leads to the development of a lump, bump, or sore on the outer layer of the skin. It is caused by a change or mutation in the DNA. It is of 4 types

1. Nodular
2. Superficial spreading
3. Pigmented
4. Sclerosing

1. Nodular Basal Cell Carcinoma: Nodular BCC is the most common form of basal cell carcinoma. It appears as a round bump, often with visible blood vessels around it.

2. Superficial Spreading: This type creates small, shallow spots on the skin that are a bit lighter than

the surrounding area. These lesions typically appear on the trunk (torso), arms, and legs

3. Pigmented : This is an uncommon form of BCC that leads to hyperpigmentation, causing a part of your skin to become darker than the surrounding areas.

4. Sclerosing: These cancerous lesions resemble scars and gradually grow larger over time. They are most commonly found on the face. This type can also appear as a small red spot on the skin.

Squamous Cell Carcinoma

Squamous cell carcinoma (SCC) is a frequently occurring skin cancer that develops from squamous cells, which are thin, flat cells that make up the outer layer of the skin. Global estimates show that SCC makes up about 20% of all skin cancers. It affects both men and women, with its occurrence generally rising as people get older. The most frequent areas for cutaneous SCC to develop are the sun-exposed parts of the skin, such as the head, neck, trunk, and limbs[7] .

Transitional Cell Carcinoma:

It is the second most frequently diagnosed cancer seen by urologists [8-9].Transitional cell carcinoma (TCC)of the upper urinary tract is a common malignancy affecting the genitourinary tract [10].

Leukemia

Leukemia is a type of cancer that impacts blood cell production in the bone marrow, leading to an abnormal increase in the number of white blood cells (leukocytosis) in both the blood and bone marrow [9-11.]

Sarcoma

Sarcoma is the leading non-rhabdomyosarcoma soft tissue sarcoma (STS) in pediatric patients, representing 30% of all STS cases diagnosed in children [12-13].

Lymphoma

It is a diverse group of malignant tumors originating from lymphocytes, which can affect lymphatic tissue, bone marrow, or extranodal locations [14].

Malenoma

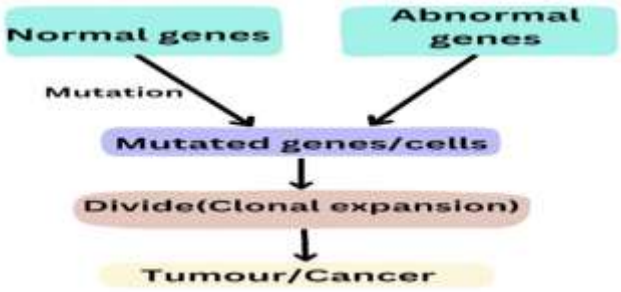
Melanoma is a cancerous growth that develops from melanocytes, the cells responsible for producing pigment in the skin [15].It originates in skin cells known as melanocytes, which are responsible for producing the pigment melanin.

Cause of cancer

Cancer development is influenced by a variety of external factors, including tobacco use, chemical exposures, radiation, and infections, as well as internal factors like genetic mutations, hormonal imbalances, immune system disorders, and random mutations. These factors collectively contribute to the initiation and progression of cancer[16]

Mechanism of cancer

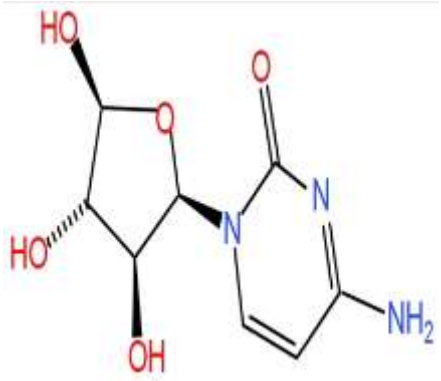
Human epithelial tissue and connective tissue play crucial roles in maintaining the structural integrity and stability of biological systems, contributing to the organization of tissues and compounds within the body .Destruction of the intermolecular structure of the original stable, produce intermolecular bifurcation, imbalance occurs between the molecules. Through genetic variation, the bifurcation direction is malignant cancer cell division [17].



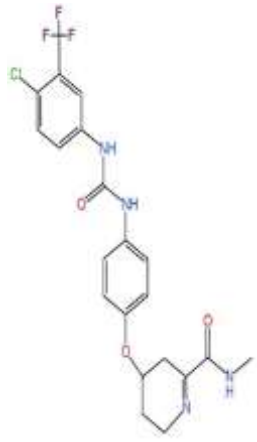
Marketed available drug which used in treatment of various cancer

MEDICINE	TREATMENT
Tamoxifen	Breast cancer
Palifermin	Mouth cancer
Magesterol acetate	Uterus cancer
Medroxyprozestrol	Uterus cancer
Cytarabine	Blood cancer
Cyclophosphamide	Blood cancer
Vincristine	Blood cancer
Carmustine	Brain cancer
Axitinib	Kidney cancer

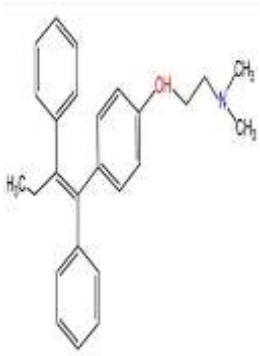
Structre of various anticancer agents which contain hetero cyclic compounds



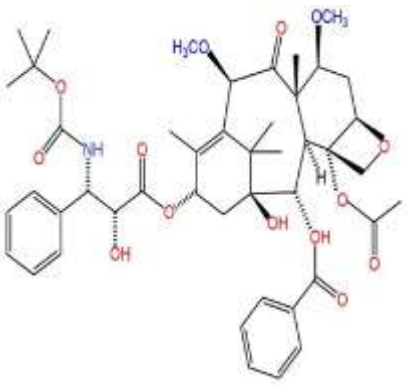
Structure of Cytarabine



Structure of Sorasenib



Structure of Tamoxifen



Structure of Cabazitaxel

Various advance techniques used in treatment cancer

There are various techniques used in treatment of cancer are

1. Chemotherapy
2. Radiotherapy
3. Hormone therapy
4. Gene therapy

Radiotherapy:

Radiotherapy, or radiation therapy, refers to the use of ionizing radiation to treat diseases, primarily cancers. Radiotherapy (RT) plays a critical role in cancer treatment, with about 50% of patients across various cancer types benefiting from its use [18].Radiation is a physical agent, which is used to destroy cancer cells [19]. There are various type of ionizing radiation are used in radiotherapy like X-rays, gamma rays, electrons, neutrons etc.

Types of radio therapy:

Radiotherapy is divided in to two types i.e.,

1. Teletheraphy
2. Brochotheraphy

Teletheraphy:

It involves using a radiation source placed away from the patient, like in super voltage machines. The radiation can come from a radioisotope, such as cobalt-60, or from linear accelerators. These accelerators produce both X-rays and electrons with energies ranging from 4 to 25 MeV (million electron volts).

Bronchotheraphy:

In this therapy the radiation device is positioned inside or near the target area. The radioactive source can be placed on the surface (Surface Mould), inside a body cavity (such as in Intracavitary Brachytherapy for the cervix or vagina), within a lumen (like Intraluminal Brachytherapy for the esophagus or anal canal), inside blood vessels (Endovascular Brachytherapy), or directly into an organ or tissue (like Interstitial Brachytherapy for the breast or soft tissue sarcomas)Mold brachytherapy involves placing sealed radiation sources near the skin to treat superficial tumors [20].In High Dose Rate (HDR) brachytherapy, catheters are positioned on or inside the patient, typically following the Manchester or Paris system [21].

Hormone therapy:

Hormone therapy (HT) is regarded as the most effective treatment for improving the quality of life in women suffering from menopausal symptoms [22-23].The primary use of hormone replacement therapy is to alleviate or prevent menopause-related symptoms, such as hot flashes and bone fractures [24].

Gene therapy:

Gene therapy is an innovative method aimed at treating, curing, or even preventing diseases by altering how a person's genes are expressed. Gene therapy offers the possibility of treating conditions that cannot be addressed with traditional medicines. It works by introducing one or more genetic materials into a patient's cells or by correcting a faulty gene. When a normal gene is introduced into the nucleus of a mutant cell, it may integrate at a different chromosomal site than the defective allele. This integration has the potential to restore the function of the mutated gene. However, there is also a risk that a new mutation could occur if the normal gene integrates into an alternate, functional gene [25-26]. Gene therapy, an advanced technology, extends beyond treating genetic disorders and has expanded into various other areas of application. The principle of gene therapy involves fixing or replacing defective genes to treat or prevent diseases. This can be done by introducing healthy genes, repairing faulty ones, or adjusting how a gene is expressed to restore its normal function. There various vectors used in gene therapy like retero virus, adeno virus, naked DNA, adeno associated virus etc. [27].

CONCLUSION

Cancer prevention involves strategies aimed at reducing the likelihood of developing cancer. This includes adopting a healthy lifestyle, minimizing exposure to known carcinogens, and using medications or vaccines that can help prevent the onset of cancer. Chemotherapy plays a critical role in oncological treatment by targeting remaining cancer cells following surgical intervention. This adjuvant therapy acts as a key preventive measure

against disease recurrence, thereby enhancing the overall prognosis for cancer patients.

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