Anticancer Drugs

Anticancer describes natural methods of health care that contribute to preventing the development of cancer or to bolstering treatment. They are meant to serve as a complement to conventional approaches (such as surgery, radiotherapy, chemotherapy)

Anticancer drug, also called “antineoplastic drug”, any drug that is effective in the treatment of malignant, or cancerous, disease. There are several major classes of anticancer drugs; these include alkylating agents, antimetabolites, natural products, and hormones. In addition, there are a number of drugs that do not fall within those classes but that demonstrate anticancer activity and thus are used in the treatment of malignant disease. The term *chemotherapy*frequently is equated with the use of anticancer drugs, although it more accurately refers to the use of chemical compounds to treat disease generally.

Types of Cancer Treatment

1. Surgery

When used to treat cancer, surgery is a procedure in which a surgeon removes cancer from your body. Learn the different ways that surgery is used against cancer and what you can expect before, during, and after surgery.

2. Radiation Therapy

Radiation therapy is a type of cancer treatment that uses high doses of radiation to kill cancer cells and shrink tumors. Radiation therapy (also called radiotherapy) is a cancer treatment that uses high doses of radiation to kill cancer cells and shrink tumors. At low doses, radiation is used in x-rays to see inside your body, as with x-rays of your teeth or broken bones. At high doses, radiation therapy kills cancer cells or slows their growth by damaging their DNA. Cancer cells whose DNA is damaged beyond repair stop dividing or die. When the damaged cells die, they are broken down and removed by the body.

Radiation therapy does not kill cancer cells right away. It takes days or weeks of treatment before DNA is damaged enough for cancer cells to die. Then, cancer cells keep dying for weeks or months after radiation therapy ends.

3. Chemotherapy

Chemotherapy is a type of cancer treatment that uses drugs to kill cancer cells.

4. Immunotherapy

Immunotherapy is a type of treatment that helps your immune system fight cancer. Immunotherapy is a type of cancer treatment that helps your immune system fight cancer. The immune system helps your body fight infections and other diseases. It is made up of white blood cells and organs and tissuesof the lymph system.
Immunotherapy is a type of biological therapy. Biological therapy is a type of treatment that uses substances made from living organisms to treat cancer.

Many different types of immunotherapy are used to treat cancer. They include:

- **Monoclonal antibodies**, which are drugs that are designed to bind to specific targets in the body. They can cause an immune response that destroys cancer cells.
  Other types of monoclonal antibodies can "mark" cancer cells so it is easier for the immune system to find and destroy them. These types of monoclonal antibodies may also be referred to as targeted therapy. See Targeted Therapy for more information.
- **Adoptive cell transfer**, which is a treatment that attempts to boost the natural ability of your T cells to fight cancer. T cells are a type of white blood cell and part of the immune system. Researchers take T cells from the tumor. They then isolate the T cells that are most active against your cancer or modify the genes in them to make them better able to find and destroy your cancer cells. Researchers then grow large batches of these T cells in the lab.

  You may have treatments to reduce your immune cells. After these treatments, the T cells that were grown in the lab will be given back to you via a needle in your vein. The process of growing your T cells in the lab can take 2 to 8 weeks, depending on how fast they grow.

  For more information about a specific type of adoptive cell transfer called CAR T-cell therapy, see CAR T-Cell Therapy: Engineering Patients' Immune Cells to Treat Their Cancers.
- **Cytokines**, which are proteins that are made by your body's cells. They play important roles in the body's normal immune responses and also in the immune system's ability to respond to cancer. The two main types of cytokines used to treat cancer are called interferons and interleukins.
- **Treatment Vaccines**, which work against cancer by boosting your immune system's response to cancer cells. Treatment vaccines are different from the ones that help prevent disease.

- **BCG**, which stands for Bacillus Calmette-Guérin, is an immunotherapy that is used to treat bladder cancer. It is a weakened form of the bacteria that causes tuberculosis. When inserted directly into the bladder with a catheter, BCG causes an immune response against cancer cells. It is also being studied in other types of cancer.

5. Targeted Therapy

Targeted therapy is a type of cancer treatment that targets the changes in cancer cells that help them grow, divide, and spread. Targeted therapy is the foundation of precision medicine. It is a type of cancer treatment that targets the changes in cancer cells that help them grow, divide, and spread. As researchers learn more about the cell changes that drive cancer, they are better able to design promising therapies that target these changes or block their effects.

Types of Targeted Therapy; Most targeted therapies are either small-molecule drugs or monoclonal antibodies.

Small-molecule drugs are small enough to enter cells easily, so they are used for targets that are inside cells.
Monoclonal antibodies are drugs that are not able to enter cells easily. Instead, they attach to specific targets on the outer surface of cancer cells.

How Targeted Therapy Works Against Cancer

Most targeted therapies help treat cancer by interfering with specific proteins that help tumors grow and spread throughout the body. They treat cancer in many different ways. They can:

- **Help the immune system destroy cancer cells.** One reason that cancer cells thrive is because they are able to hide from your immune system. Certain targeted therapies can mark cancer cells so it is easier for the immune system to find and destroy them. Other targeted therapies help boost your immune system to work better against cancer.
- **Stop cancer cells from growing.** Healthy cells in your body usually divide to make new cells only when they receive strong signals to do so. These signals bind to proteins on the cell surface, telling the cells to divide. This process helps new cells form only as your body needs them. But, some cancer cells have changes in the proteins on their surface that tell them to divide whether or not signals are present. Some targeted therapies interfere with these proteins, preventing them from telling the cells to divide. This process helps slow cancer's uncontrolled growth.

- **Stop signals that help form blood vessels.** Tumors need to form new blood vessels to grow beyond a certain size. These new blood vessels form in response to signals from the tumor. Some targeted therapies are designed to interfere with these signals to prevent a blood supply from forming. Without a blood supply, tumors stay small. Or, if a tumor already has a blood supply, these treatments can cause blood vessels to die, which causes the tumor to shrink.
- **Deliver cell-killing substances to cancer cells.** Some monoclonal antibodies are combined with toxins, chemotherapy drugs, and radiation. Once these monoclonal antibodies attach to targets on the surface of cancer cells, the cells take up the cell-killing substances, causing them to die. Cells that don't have the target will not be harmed.
- **Cause cancer cell death.** Healthy cells die in an orderly manner when they become damaged or are no longer needed. But, cancer cells have ways of avoiding this dying process. Some targeted therapies can cause cancer cells to go through this process of cell death.
- **Starve cancer of the hormones it needs to grow.** Some breast and prostate cancers require certain hormones to grow. Hormone therapies are a type of targeted therapy that can work in two ways. Some hormone therapies prevent your body from making specific hormones. Others prevent the hormones from acting on your cells, including cancer cells.

6. **Hormone Therapy**

Hormone therapy is a treatment that slows or stops the growth of breast and prostate cancers that use hormones to grow. Hormone therapy is a cancer treatment that slows or stops the growth of cancer that uses hormones to grow. Hormone therapy is also called hormonal therapy, hormone treatment, or endocrine therapy. How Hormone Therapy Works against Cancer;

- **Treat cancer.** Hormone therapy can lessen the chance that cancer will return or stop or slow its growth.
- **Ease cancer symptoms.** Hormone therapy may be used to reduce or prevent symptoms in men with prostate cancer who are not able to have surgery or radiation therapy.

Types of Hormone Therapy; Hormone therapy falls into two broad groups, those that block the body's ability to produce hormones and those that interfere with how hormones behave in the body. When used with other treatments, hormone therapy can:

- Make a tumor smaller before surgery or radiation therapy. This is called neo-adjuvant therapy.
- Lower the risk that cancer will come back after the main treatment. This is called adjuvant therapy.
- Destroy cancer cells that have returned or spread to other parts of your body.

7. Stem Cell Transplant

Stem cell transplants are procedures that restore blood-forming stem cells in cancer patients who have had theirs destroyed by very high doses of chemotherapy or radiation therapy. Stem cell transplants are procedures that restore blood-forming stem cells in people who have had theirs destroyed by the very high doses of chemotherapy or radiation therapy that are used to treat certain cancers.

Blood-forming stem cells are important because they grow into different types of blood cells. The main types of blood cells are:

- White blood cells, which are part of your immune system and help your body fight infection
- Red blood cells, which carry oxygen throughout your body
- Platelets, which help the blood clot

Types of Stem Cell Transplants

In a stem cell transplant, you receive healthy blood-forming stem cells through a needle in your vein. Once they enter your bloodstream, the stem cells travel to the bone marrow, where they take the place of the cells that were destroyed by treatment. The blood-forming stem cells that are used in transplants can come from the bone marrow, bloodstream, or umbilical cord. Transplants can be:

- Autologous, which means the stem cells come from you, the patient
- Allogeneic, which means the stem cells come from someone else. The donor may be a blood relative but can also be someone who is not related.
- Syngeneic, which means the stem cells come from your identical twin, if you have one

To reduce possible side effects and improve the chances that an allogeneic transplant will work, the donor's blood-forming stem cells must match yours in certain ways. To learn more about how blood-forming stem cells are matched, see Blood-Forming Stem Cell Transplants.

How Stem Cell Transplants Work against Cancer

Stem cell transplants do not usually work against cancer directly. Instead, they help you recover your ability to produce stem cells after treatment with very high doses of radiation therapy, chemotherapy, or both.

However, in multiple myeloma and some types of leukemia, the stem cell transplant may work against cancer directly. This happens because of an effect called graft-versus-tumor that can occur after allogeneic transplants. Graft-versus-tumor occurs when white blood cells from your donor (the graft) attack any cancer cells that remain in your body (the tumor) after high-dose treatments. This effect improves the success of the treatments.

8. Precision Medicine

Precision medicine helps doctors select treatments that are most likely to help patients based on a genetic understanding of their disease. Learn about the role precision medicine plays in cancer treatment, including how genetic changes in a person's cancer are identified and used to select treatments. Precision medicine is an approach to patient care that allows doctors to select treatments that are most likely to help patients based on a geneticunderstanding of their disease. This may also be called personalized medicine. The idea of precision medicine is not new, but recent advances in science and technology have helped speed up the pace of this area of research.

Today, when you are diagnosed with cancer, you usually receive the same treatment as others who have same type and stage of cancer. Even so, different people may respond differently, and, until recently, doctors didn't know why. After decades of research, scientists now understand that patients' tumors have genetic changes that cause cancer to grow and spread. They have also learned that the changes that occur in one person's cancer may not occur in others who have the same type of cancer. And, the same cancer-causing changes may be found in different types of cancer.

The Promise of Precision Medicine; The hope of precision medicine is that treatments will one day be tailored to the genetic changes in each person's cancer. Scientists see a future when genetic tests will help decide which treatments a patient's tumor is most likely to respond to, sparing the patient from receiving treaments that are not likely to help. Research studies are going on now to test whether treating patients with treatments that target the cancer-causing genetic changes in their tumors, no matter where the cancer develops in the body, will help them. Many of these treatments are drugs known as targeted therapies.

How Chemotherapy Is Used With Other Cancer Treatments; When used with other treatments, chemotherapy can:

- Make a tumor smaller before surgery or radiation therapy. This is called neoadjuvant chemotherapy.
- Destroy cancer cells that may remain after treatment with surgery or radiation therapy. This is called adjuvant chemotherapy.
- Help other treatments work better.
- Kill cancer cells that have returned or spread to other parts of your body.

How Chemotherapy Is Given; Chemotherapy may be given in many ways. Some common ways include:

- **Oral**
  The chemotherapy comes in pills, capsules, or liquids that you swallow
- **Intravenous,(IV)**
  The chemotherapy goes directly into a vein
- **Injection**
  The chemotherapy is given by a shot in a muscle in your arm, thigh, or hip, or right under the skin in the fatty part of your arm, leg, or belly
- **Intrathecal**
  The chemotherapy is injected into the space between the layers of tissue that cover the brain and spinal cord
- **Intraperitoneal,(IP)**
  The chemotherapy goes directly into the peritoneal cavity, which is the area in your body that contains organs such as your intestines, stomach, and liver

- **Intra-arterial,(IA)**
  The chemotherapy is injected directly into the artery that leads to the cancer
- **Topical**
  The chemotherapy comes in a cream that you rub onto your skin

Side Effects of Cancer Treatment

Cancer treatments can cause side effects-problems that occur when treatment affects healthy tissues or organs.

- Anemia
- Appetite Loss
- Bleeding and Bruising (Thrombocytopenia)
- Constipation
- Delirium
- Diarrhea
- Edema (Swelling)
- Fatigue
- Fertility Issues in Boys and Men
- Fertility Issues in Girls and Women
- Hair Loss (Alopecia)
- Infection and Neutropenia
- Lymphedema
- Memory or Concentration Problems
- Mouth and Throat Problems
- Nausea and Vomiting
- Nerve Problems (Peripheral Neuropathy)
- Pain
- Sexual Health Issues in Men
- Sexual Health Issues in Women
- Skin and Nail Changes
- Sleep Problems
- Urinary and Bladder Problems

Types of Antineoplastics

1. Alkylating agents
2. Antibiotics/antineoplastics
3. Antimetabolites
4. Antineoplastic interferons
5. Protein tyrosine kinase inhibitors
6. Hormones/antineoplastics
7. Vinca alkaloidleri
8. Platinium compounds

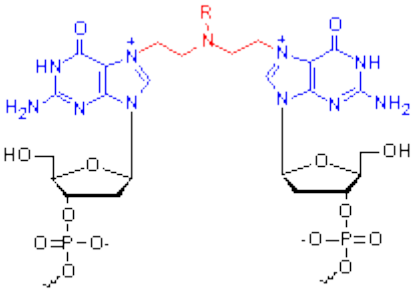
1. Alkylating agents

Alkylating agents are compounds that work by adding an alkyl group to the guanine base of the DNA molecule, preventing the strands of the double helix from linking as they should. This causes breakage of the DNA strands, affecting the ability of the **cancer** cell to multiply. Eventually, the cancer cell dies. Alkylating agents were one of the first classes of drugs to be used against cancer. There are five traditional categories of alkylating agents:

- Nitrogen mustards (eg, bendamustine, chlorambucil, cyclophosphamide, ifosfamide, mechlorethamine, melphalan)
- Nitrosoureas (eg, carmustine, lomustine, streptozocin)
- Alkyl sulfonates (eg, busulfan)
- Triazines (eg, dacarbazine, temozolomide)
- Ethylenimines (eg, altretamine, thiotepa)

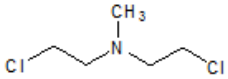
Trabectedin is classed as a tetrahydroisoquinoline alkaloid, and unlike traditional alkylating agents, it binds to the minor groove of DNA and alkylates guanine at the N2 position. Alkylating agents are effective during every phase of the life cycle of a cancer cell, which means they are effective for treating a wide range of cancers. They are most effective for treating slow-growing cancers such as leukemiaand solid tumors, but are also used in the treatment of breast, lung,

ovarian, and prostate cancers; lymphomas, myelomas, and sarcomas; and Hodgkin's disease. Because alkylating agents affect all cells that are dividing frequently, they are also toxic to normal cells, particularly those of the gastrointestinal tract, bone marrow, testicles, and ovaries. Note: Although the platinum-containing anticancer agents, carboplatin, cisplatin, and oxaliplatin are frequently classified as alkylating agents, they are not. They cause covalent DNA adducts by another means.

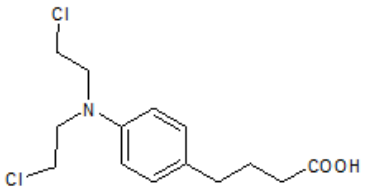


DNA crosslink formed from reaction at N-7 guanine on both strands (G-G crosslink)

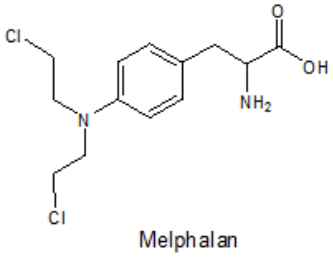
1.1. N- chlorethylamine derivatives



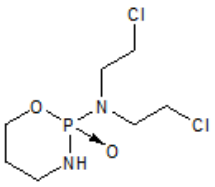
Chlormethine



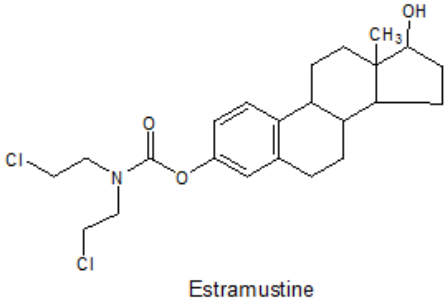
Chlorambucil



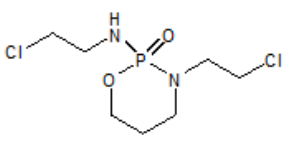
Melphalan



Cyclophosphamide

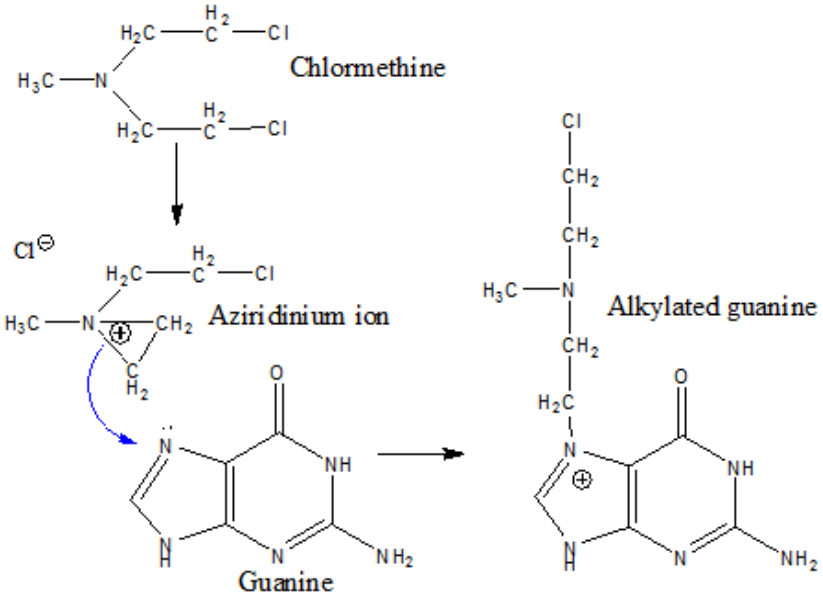


Estramustine

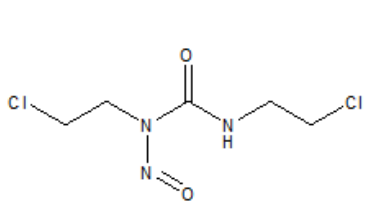


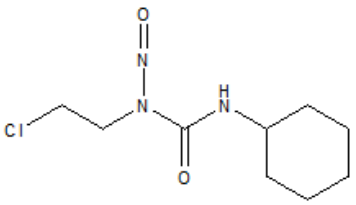
Ifosfamide

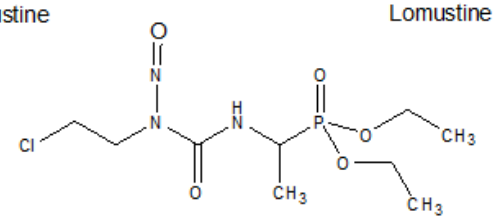
Alkylating agents mechanism

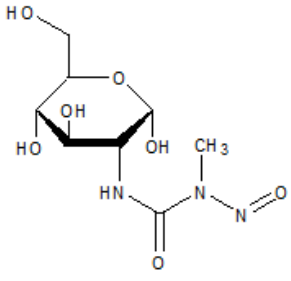


1.2. Nitrosoureas

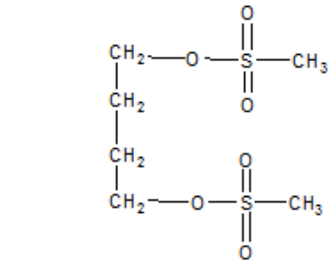

Carmustine


Lomustine

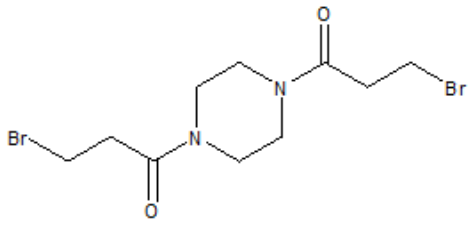

Fotemustine


Streptozocin

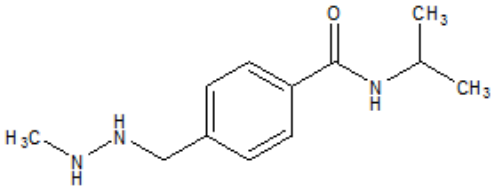
1.3. Alkyl sulfonates and others



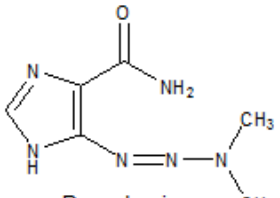
Busulfan



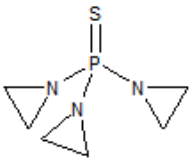
Pipobroman



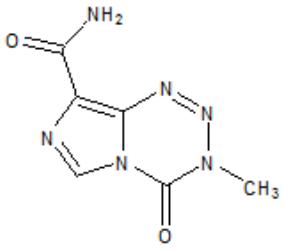
Procarbazine



Dacarbazine



Thiotepa

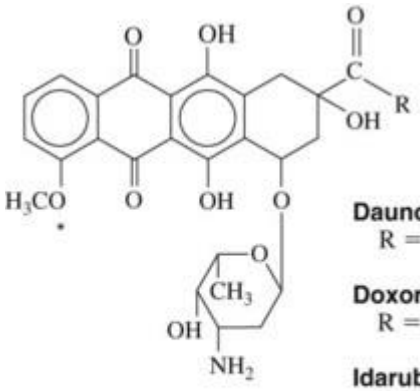


Temozolomide

2. Antibiotics/antineoplastics

An antibiotic is a compound which inhibits the growth of bacteria (bacteriostatic effect) or destroys them (bactericidal effect). The antibiotic effect can be obtained by different mechanisms of which damage of the microbial DNA. The fact that antibiotics, generally well tolerated, can damage DNA can appear surprising. This discordance between a good tolerance and a mechanism of action, in theory aggressive, is explained by the following facts:

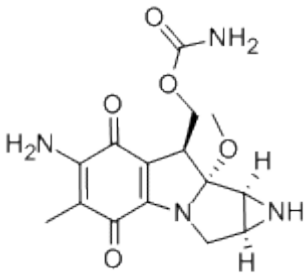
1. Certain antibiotics are not toxic by themselves, but only after conversion into toxic derivatives by enzymes present in microorganisms and not in human cells.
2. There are many differences between bacterial and human chromosomes. The human chromosomes are separated from the cytoplasm by a nuclear membrane, they are much condensed and are linked to basic proteins, called histones, which could protect them.
3. The human topoisomerase II is different from the bacterial topoisomerase II, particularly by the number of subunits.



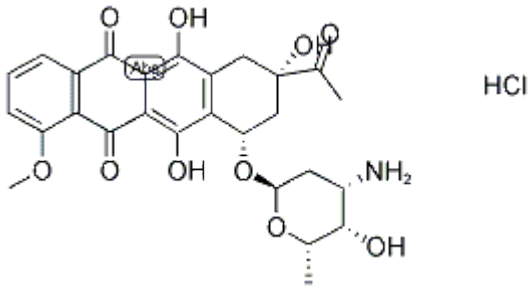
Daunorubicin
R = CH_3

Doxorubicin
R = CH_2OH

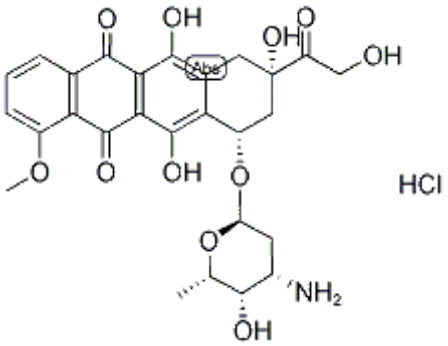
Idarubicin
*Differs from daunorubicin in the substitution of a proton for the methoxy (—OCH_3) on the "D" ring.



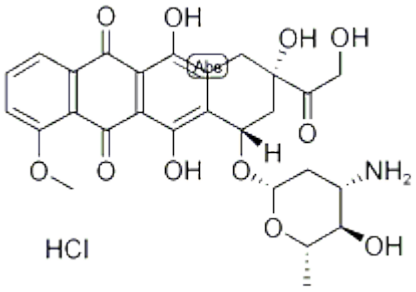
Mytomicyn C



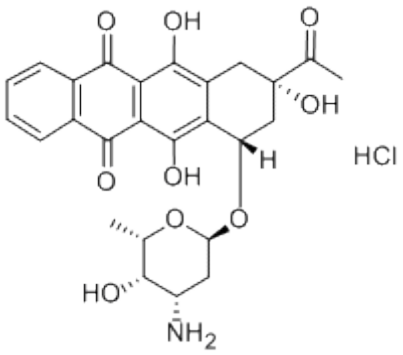
Daunorubicin hydrochloride



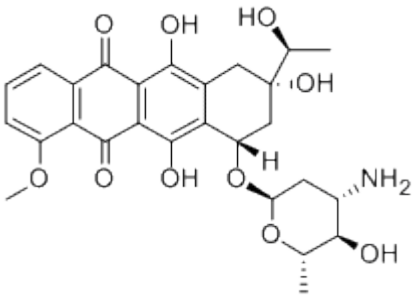
Doxorubicin hydrochloride



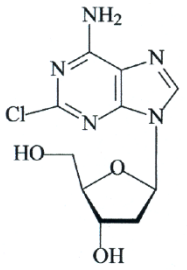
Epirubicin hydrochloride



Idarubicin hydrochloride

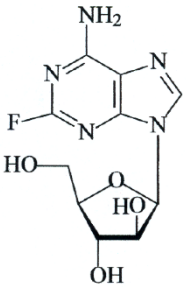


Daunomycinol



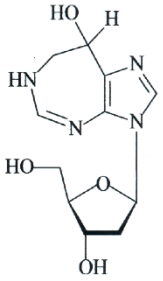
Cladribine

2-chloro-9-(2'-deoxy--β-D-ribofuranosyl)-adenine (2-CdA)



Fludarabine

2-fluoro-9-(β-D-arabinofuranosyl)-adenine (FA)



Pentostatin

2'-deoxycoformycin (DCF)

3. Antimetabolites

Antimetabolites are drugs that interfere with one or more enzymes or their reactions that are necessary for DNA synthesis. They affect DNA synthesis by acting as a substitute to the actual metabolites that would be used in the normal metabolism (for example antifolates interfere with the use of folic acid).

Antimetabolites are drugs used in **cancer** chemotherapy. Cancer cells divide more rapidly compared to normal cells so antimetabolites affect cancer cell replication more than they affect normal cell replication.

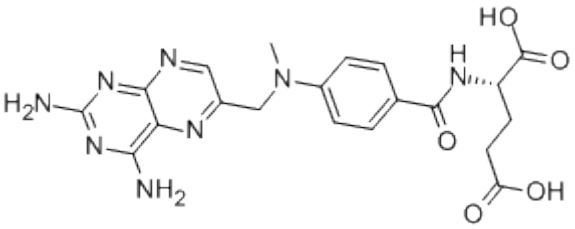
Antimetabolites are types of chemotherapy treatments that are very similar to normal substances within the cell. When the cells incorporate these substances into the cellular metabolism, they are unable to divide. Antimetabolites are cell-cycle specific. They attack cells at very specific phases in the cycle. Antimetabolites are classified according to the substances with which they interfere.

Folic acid antagonist: Methotrexate.

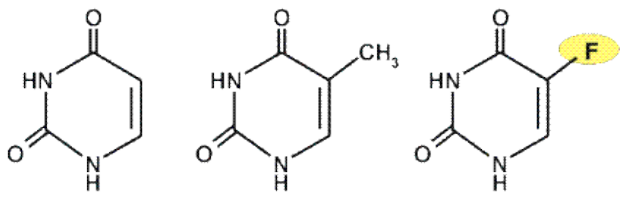
Pyrimidine antagonist: 5-Fluorouracil, Foxuridine, Cytarabine, Capecitabine, and Gemcitabine.

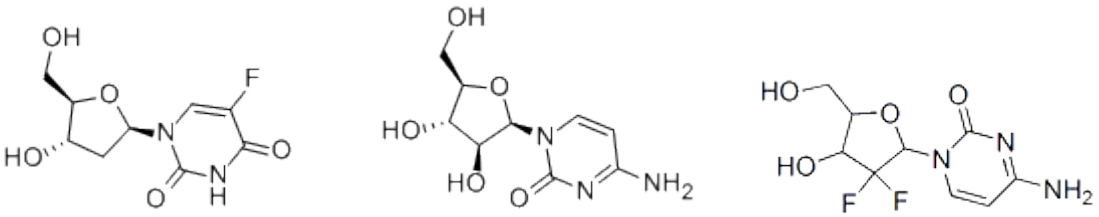
Purine antagonist: 6-Mercaptopurine and 6-Thioguanine.

Adenosine deaminase inhibitor: Cladribine, Fludarabine, Nelarabine and Pentostatin.

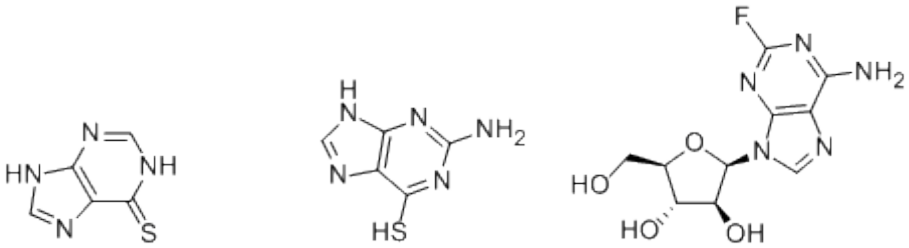


Methotrexate

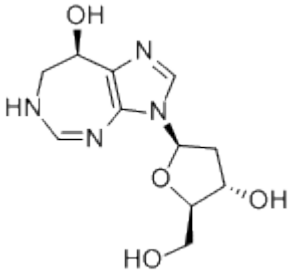


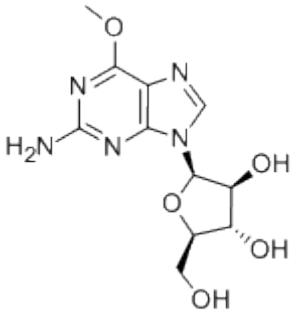


Floxuridine Cytarabine Gemcitabine



6-Mercaptopurine 6-Thioguanine Fludarabine





Pentostatin Nelarabine

4. Antineoplastic interferons

Antineoplastic interferons are interferons (alpha) that are manufactured using recombinant DNA technology and used therapeutically to treat certain types of cancers and viral infections.

Natural interferons enhance the immune system in many ways so can be used to treat different conditions involving the immune system. Interferons are proteins produced by host cells that are infected with viruses, bacteria, other unknown nucleic acids or tumor cells. Interferons also activate other cells that serve as part of the immune system, and destroy invading pathogens. Antineoplastic interferons are used as part of the treatment for cancers like angioblastoma, chronic myelogenous leukemia and hairy cell leukemia, certain types of lymphomas, AIDS-related Kaposi sarcoma and malignant melanomas. They are also used in the treatment of viral infections such as hepatitis B and C, and human papillomavirus.

5. Protein tyrosine kinase inhibitors

A protein kinase inhibitor is a type of enzyme inhibitor that can block the action of protein kinases. Protein kinases add a phosphate group to a protein in a process called phosphorylation, which can turn a protein on or off and therefore affect its level of activity and function.

Protein kinase inhibitors can be subdivided according to the amino acid on a protein that they add the phosphate to (e.g serine, threonine or tyrosine) in order to inhibit phosphorylation of

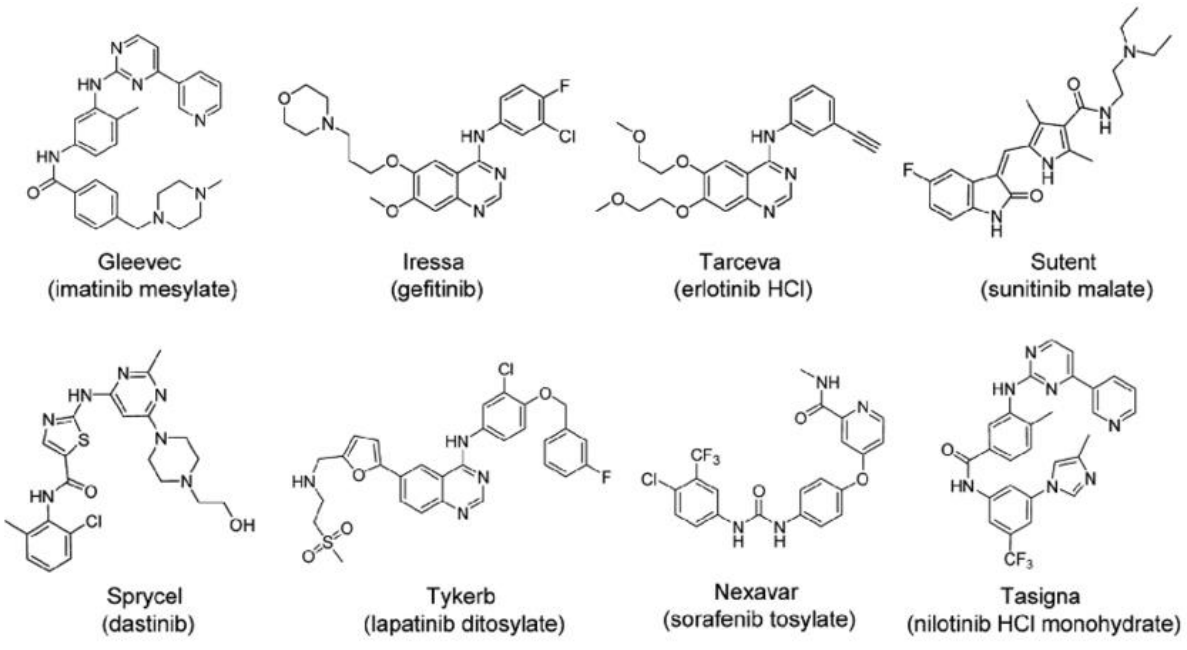
that amino acid. Kinases mostly act on both serine and threonine, but tyrosine kinase acts on tyrosine only and some dual-specificity kinases act on all three of these amino acid residues. Some protein kinases also phosphorylate other amino acids, such as histidine kinases that act on histidine residues.

Phosphorylation is often a required step in the growth of some cancers and inflammatory disorders, meaning inhibition of the enzymes that trigger phosphorylation provides an approach to treating such diseases.

One example of a drug being used in this way is the tyrosine kinase inhibitor dasatinib, which is used as an anticancer therapy in several forms of leukemia. Another agent currently being tested in clinical trials for polycystic kidney disease is PLX5568.

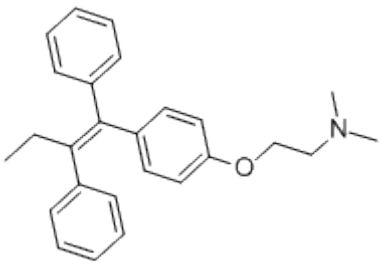
Tyrosine kinase inhibitors are particularly important agents because these high-affinity cell surface receptors play a critical role in the progression of many cancers.

Tyrosine kinases are involved in various cell functions including cell signalling, cell growth and cell division. In some forms of cancer, these enzymes are present in high levels or overactive and inhibiting them can prevent the proliferation of cancer cells. Tyrosine kinase inhibitors therefore provide an important form of targeted therapy in the fight against cancer.

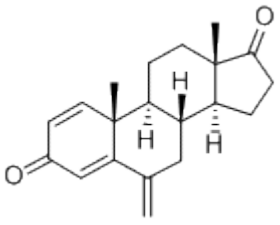


6. Hormones/antineoplastics

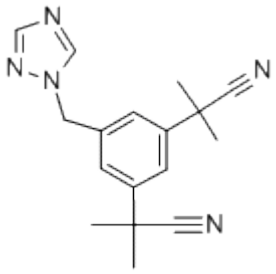
Hormonal antineoplastic drugs of action is usually considered to function by binding with specific hormone receptors. Hormone receptors, all of which are cytoplasmic protein and nucleoprotein, combined with the hormone with high affinity and specificity. After penetrating the cell membrane and getting into the cells, endogenous or exogenous steroids bind to specific receptors and form the hormone-receptor complexes and activated into the nucleus. The activated hormone receptor complexes, binding to specific receptors of chromatin, react with the role of various components of the nucleus, which causes DNA replication and cell division by a series of enzymatic reactions, thus affecting the physiological function of cells. Adrenocorticotropic hormone, that works on lymphocytes, making it dissolve directly and inhibiting mitosis role, plays an important role in the treatment of lymphoma, leukemia and multiple myeloma. It should be attached care in the use of hormone to treat related tumors, and the hormone must be selected carefully by theoretical basis, in line with the indications, and with dosage properly, otherwise it will promote the growth of tumor cells, just the opposite. This antineoplastic drugs include aromatase inhibitors, aromatase inactivator, estrogens, anti-estrogens, progestins, androgens, anti-androgens, luteinizing hormone agonists, glucocorticoids hormones, adrenal blockers and others.



Tamoxifen



Exemestane



Anastrozole

7. Vinca alkaloidleri

Four major vinca alkaloids are in clinical use for cancer: vinblastine, vinorelbine, vincristine, and vindesine. These are sometimes called monoterpenoid indole alkaloids in the scientific

literature. All vinca alkaloids are administered intravenously (IV). They are eventually metabolized by the liver and excreted.

The vinca alkaloids are cytotoxics – they halt the division of cells and cause cell death. During cell division, vinca alkaloid molecules bind to the building blocks of a protein called tubulin, inhibiting its formation. The drugs work during the M-phase of cell reproduction. Tubulin protein normally works in cells to create "spindle fibers" (also called microtubules). These microtubules provide cells with both the structure and flexibility they need to divide and replicate. Without microtubules, cells cannot divide. The vinca alkaloid's mechanism in a nutshell: by occupying tubulin's building block structure, vinca alkaloids prevent cancer cells from successfully dividing.

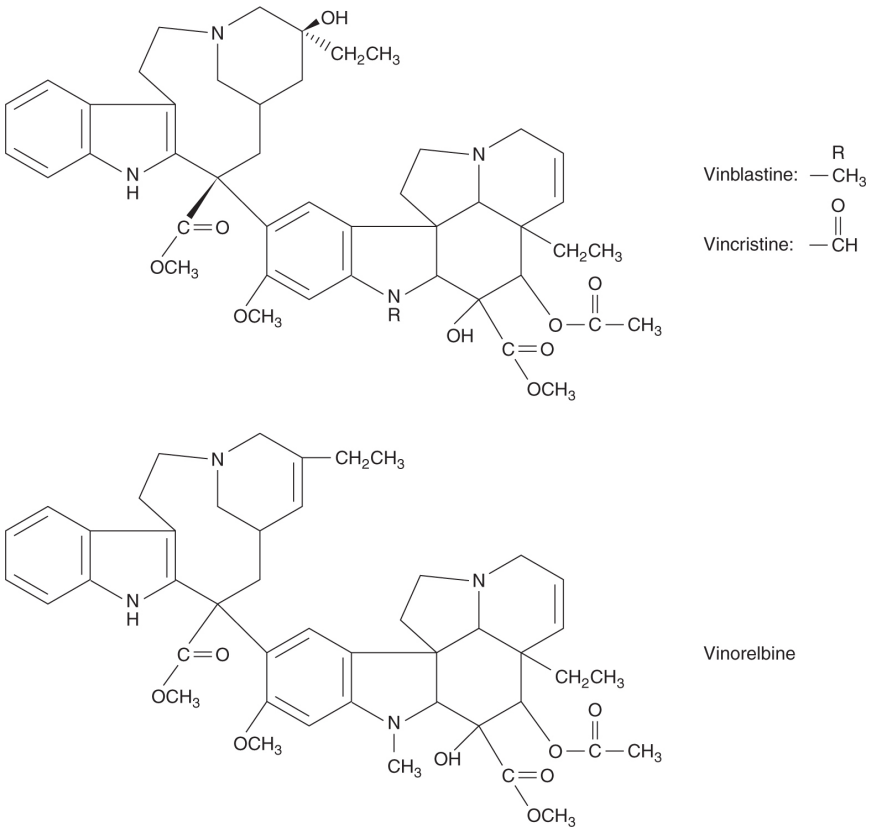
Vinblastine inhibits angiogenesis, or the process by which new blood vessels grow from pre-existing ones. Angiogenesis is an essential step in a tumor's transition to malignancy. Vinblastine is most often applied to treat Hodgkin's disease, non-Hodgkin's lymphoma, breast cancer, and germ cell tumors. Side effects of vinblastine include: toxicity to white blood cells, nausea, vomiting, constipation, dyspnea, chest or tumor pain, wheezing, and fever. Vinblastine sometimes causes antidiuretic hormone secretion and angina.

Vinorelbine acts the same way as vinblastine. Vinorelbine has exhibited significant antitumor activity in patients with breast cancer and antiproliferation effects on osteosarcoma (bone tumor cells). Furthermore, vinorelbine has been shown to decrease the stability of lipid bilayer membranes (like those of a cell's). Vinorelbine's side effects include: decreased resistance to infection, bruising or bleeding, anemia, constipation, diarrhea, nausea, numbness or tingling in the hands and feet, fatigue (also called peripheral neuropathy), and inflammation at the injection site. Less common side effects include hair loss and allergic reaction.

Vincristine's inhibition of microtubule formation is especially powerful. The reason for this comes from the fact that tubulin protein is dynamic. Its long chain of building blocks is always growing in some places and breaking in others. The less contiguous parts of a tubulin molecule have pieces only two building blocks long, called dimers. Vincristine has a high affinity for tubulin dimers, and the reaction between vincristine and the dimers is rapidly reversible. That means a vincristine molecule will attach to a dimer at one site, break off, and then reattach at another site. This keeps two sites per dimer "poisoned" and unable to reassemble into the protein. So vincristine's ability to destabilize tubulin is especially good.

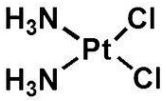
Vincristine is FDA approved to treat acute leukemia, rhabdomyosarcoma, neuroblastoma, Wilm's tumor, Hodgkin's disease, and other lymphomas. Vincristine's most common side effects are: peripheral neuropathy, suppression of bone marrow activity, constipation, nervous system toxicity, nausea, and vomiting.

Vindesine has a serum half-life of only 24 hours, but similar effects (intended and side) to that of vinblastine. Vindesine is administered at a dose of 3 milligrams per square meter of body surface. The drug is applied to treat melanoma, lung cancers, and (combined with other drugs) uterine cancers. Additional side effects from vindesine include: anemia, blood cell toxicity, fatigue, tingling or pricking sensations in the skin, and skin toxicity.

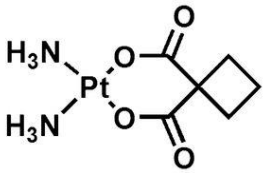


8. Platinium compounds

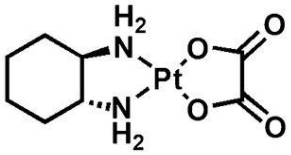
Strategies for improving **platinum**-based **anticancer** drugs usually involve changes in the neutral spectator ligands, which are usually nitrogenous. Changes in the nature of the anions (halides vs various carboxylates), and changes in the oxidation state of the metal (Pt(II) vs Pt(IV)).



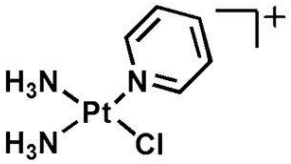
cisplatin



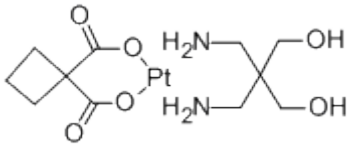
carboplatin



oxaliplatin



pyriplatin



Zeniplatin