# 1 *Medicinal Plants with Anticancer Properties*

## Introduction to Cancer

Cancer can be defined as a disease in which a group of abnormal cells grow uncontrollably by disregarding the normal rules of cell division. Normal cells are subject to signals that dictate whether the cell should divide, differentiate into another cell or die. Cancer cells develop a degree of autonomy from these signals, resulting in uncontrolled growth and proliferation. If this proliferation is allowed to continue and spread, it can be fatal. In fact almost 90% of cancer related deaths are due to tumor spreading- a process called metastasis.

The foundation of modern cancer cell biology rests on a simple principle- virtually all mammalian cells share similar molecular networks that control cell proliferation, differentiation and cell death. The prevailing theory, which underpins research into the genesis and treatment of cancer, is that normal cells are transformed into abnormal cancer cells as a result of changes in the network of biochemical, molecular and cellular level, and for each cell there is a finite number of ways by which this disruption can occur.

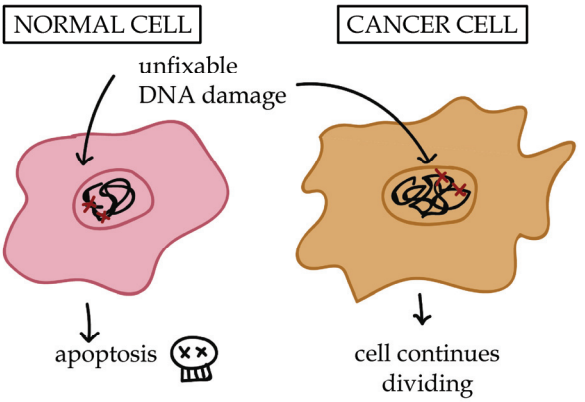
Phenomenal advances in cancer research in the past 50 years have given an insight into how cancer cells develop this autonomy. Now cancer is defined as a disease that involves changes or mutations in the cell genome. These changes (DNA mutations) produce proteins that disrupt the delicate cellular balance between cell division and quiescence, resulting in cells that keep dividing to form cancers.

### Insights into Cancer

Initiation and progression of cancer depends on both external factors in the environment (tobacco, chemicals, radiation and

infectious organisms), and factors within the cell (inherited mutations, hormones, immune conditions). These factors can act together or in sequence, resulting in abnormal cell behavior and excessive proliferation. As a result, cell masses grow and expand, affecting surrounding normal tissues (such as in the brain), and can also spread to other locations in the body (metastasis). However, it is important to remember that most common cancers take months and years for these DNA mutations to accumulate and result in a detectable cancer.

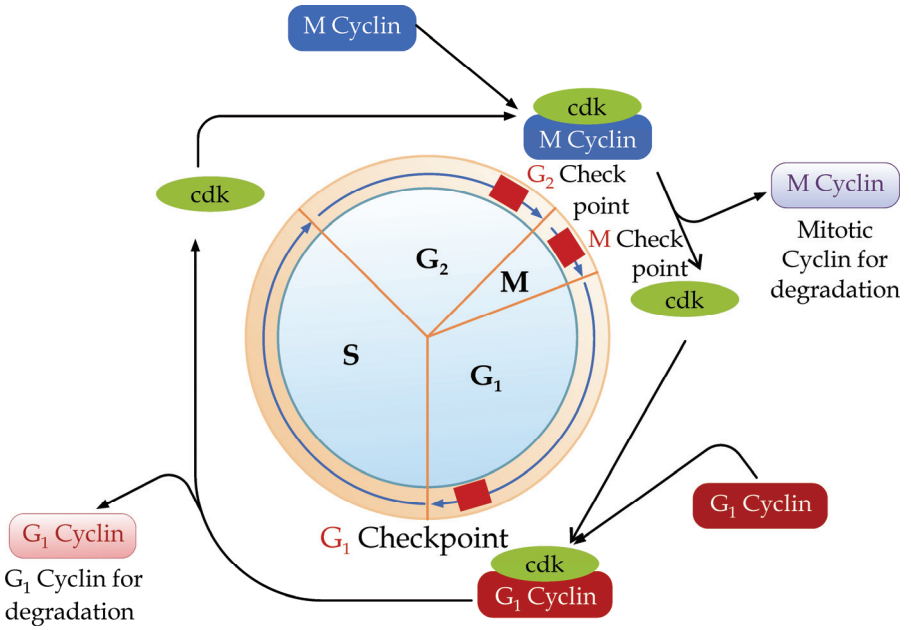
Cancers occur approximately in one among every 3 individuals. DNA mutations arise normally at a frequency of 1 in every 20 million per gene per cell division. The average number of cells formed in any individual during an average lifetime is $10^{16}$(10 million cells being replaced every 16 seconds). It would be therefore logical to assume that human populations anywhere in the world would show similar frequencies of cancer. However, cancer incidence rates vary dramatically across countries. Evidently, some factors seem to intervene to increase cancer incidences in some population. Schematic sketch of cell division is shown in the figure below.




## Cancer Cell Division

When it comes to cell division, cancer cells multiply uncontrollably and very rapidly. It can divide without any external signals; cancer cells do not exhibit contact inhibition. M phase starts after completion of S phase, in other words DNA replication must not start until mitosis is complete and mitosis must not begin until the

previous round of DNA replication has ended, thus the integrity of genome is maintained. In between S and M phases two gaps, G1 and G2 are there. G1 follows from mitosis and is in a time during the cell cycle when the cell is responsive to both positive and negative growth signals. G2 is the gap after S phase, when the cell prepares for entry into mitosis. Finally, the last stage G0 phase occurs.




## Types of Cancer

There are more than 100 types of cancers. The type of cancer is named according to the organ from where it is originated. The most common of them are sarcoma, adenoma, carcinoma, melanoma, leukemia and lymphoma.

### Carcinoma

Carcinomas are the most common types of cancer. They are formed by epithelial cells. There are many types of epithelial cells, which often have a column-like shape when viewed under a microscope. Adenocarcinoma is a cancer that forms in epithelial cells that produce fluids or mucus. Tissues with this type of epithelial cell are sometimes called glandular tissues. Most cancers of the breast, colon and prostate are adenocarcinomas.

Transitional cell carcinoma is a cancer that forms in a type of epithelial tissue called transitional epithelium, or urothelium. This tissue, which is made up of many layers of epithelial cells that can get bigger and smaller, is found in the linings of the bladder, ureters, and part of the kidneys (renal pelvis), and a few other organs. Some cancers of the bladder, ureters and kidneys are transitional cell carcinomas.

## Sarcoma

Sarcomas are cancers that form in bone and soft tissues, including muscle, fat, blood vessels, lymph vessels and fibrous tissue (such as tendons and ligaments). Osteosarcoma is the most common cancer of bone.

## Leukemia

Cancers that begin in the blood-forming tissue of the bone marrow are called leukemias. These cancers do not form solid tumors. Instead, large numbers of abnormal white blood cells (leukemia cells and leukemic blast cells) build up in the blood and bone marrow, crowding out normal blood cells. The low level of normal blood cells can make it difficult for the body to get oxygen to its tissues, control bleeding, or fight infections.

There are four common types of leukemia, which are grouped based on the rapidity of spread of the disease (acute or chronic) and the type of blood cell on which the cancer starts in (lymphoblastic or myeloid).

## Lymphoma

Lymphoma is cancer that begins in lymphocytes (T cells or B cells). These are disease-fighting white blood cells that are part of the immune system. In lymphoma, abnormal lymphocytes build up in lymph nodes and lymph vessels, as well as in other organs of the body.

There are two main types of lymphoma:

***Hodgkin lymphoma:*** People with this disease have abnormal lymphocytes that are called Reed-Sternberg cells. These cells usually form from B cells.

***Non-Hodgkin lymphoma:*** This is a large group of cancers that start in lymphocytes. The cancers can grow quickly or slowly and can form from B cells or T cells.

### Melanoma

Melanoma is the cancer that begins in cells that become melanocytes, which are specialized cells that make melanin (the pigment that gives skin its color). Most melanomas form on the skin, but melanomas can also form in other pigmented tissues, such as the eye.

### Brain and Spinal Cord Tumors

There are different types of brain and spinal cord tumors. These tumors are named based on the type of cell in which they are formed and where the tumor is first formed in the central nervous system.

## Other Types of Tumors

### Germ Cell Tumors

Germ cell tumors are a type of tumor that begins in the cells that give rise to sperm or eggs. These tumors can occur almost anywhere in the body and can be either benign or malignant.

### Neuroendocrine Tumors

Neuroendocrine tumors form from cells that release hormones into the blood in response to a signal from the nervous system. These tumors, which may make higher-than-normal amounts of hormones, can cause many different symptoms. Neuroendocrine tumors may be benign or malignant.

### Carcinoid Tumors

Carcinoid tumors are a type of neuroendocrine tumor. They are slow-growing tumors that are usually found in the gastrointestinal system (most often in the rectum and small intestine). Carcinoid tumors may spread to the liver or other sites in the body, and they may secrete substances such as serotonin or prostaglandin.

## Plants having Anti-Cancer Potentials

1. *Betula alba*

   ***Common name:*** Birch

   ***Chemical constituents:*** The bark of birch contains about 3 percent tannic acid, which is used as a tannic acid. The white epidermis of the bark contains empyreumatic oil, also known as birch tar. The tar is almost identical to Wintergreen oil but contains a high concentration of methyl salicylate. It also contains creosol and guailacol. Besides the tar, the bark also contains salicylate and methyl salicylate. Other constituents include saponins, flavonoids, glycosides, quercitrin, kaempferol etc.

   ***Pharmacological activities:*** The betulinic acid has been known to kill cancerous cells and has been especially effective in the treatment of prostate cancer patients[1].

   ***Distribution:*** The Birch has sixty species throughout the world, ten of which are native to Canada and the northern part of the United States.

2. *Colchicum autumnale* **(Liliaceae)**

   ***Common name:*** Naked ladies, meadow saffron and colchicum.

   ***Chemical constituents:*** Colchicum seeds contain 0.2-1% of amino alkaloids of which colchicine is the main constituent. The seeds contain up to 0.8 per cent of colchicine and in corms, it is up to 0.6%. Colchicum also contains demecolcine. Both the alkaloids contain tropolone or cycloheptatrien-ol-one ring structure.

   ***Pharmacological activities:*** Colchicine obtained from Colchicum plant works by interrupting the process of division of cancerous cells[1].

   ***Distribution:*** The Autumn Crocus, of the Lily Family (Liliaceae), is a plant with small flowers of varying colors. This plant is indigenous to Europe, Northern Africa and Asian continents. Being a plant with a history of medicinal use, records show that it was used in Ancient Greece, India, and Egypt.

3. *Camptotheca acuminata*

   ***Common name:*** Xi Shu, Happy Tree, the Camptotheca

***Chemical constituents:*** The bark and stems of *C. acuminata* contain the alkaloid camptothecin. Several chemical derivatives of camptothecin are under investigation for or used as drugs for cancer treatment, including irinotecan, topotecan, rubitecan. *C. acuminata* also contains the chemical compounds trifolin and hyperoside.

***Pharmacological activities:*** Camptothecin is helpful in brain tumors through the drug Irinotecan. It contains antineoplastic, used to prevent the mutation of cells into cancerous cells with the possibility of preventing or reducing the disease into one that is benign[1].

***Distribution:*** Three living species in the genus Camptotheca are now recognized with the extant natural distribution restricted to remote regions in southern China. However, neither the geographical distribution nor the resource availability in China was investigated prior to the surveys. Consequently, such data are not available in either the government forestry departments or universities, or in the botanical and medical institutions.

**4.** ***Curcuma zedoaria***

***Common name:*** White turmeric, Zedoary root

***Chemical constituents:*** (+)- germacrone-4, 1,8-cineole, 5-epoxide, germacrone, furanodienone, curzerenone, zederone, dehydrocurdione, curcumenol, isocurcumenol, curcumenone, curmanolide A, curmanolide B.

***Pharmacological activities:*** Polysaccharides and protein bound polysaccharides obtained from *C.zedoaria* could inhibit the growth of Sarcoma- 180[2,3]. Essential oil from *C.zedoaria* has an antiproliferative effect on MCF-7, HL-60 and OVCAR-3 cells[4,7].

***Distribution:*** Zedoary plant is native to India and Indonesia. However, it is widely used as a spice in the West today. It is also found in sub-tropical regions of eastern Nepal.

**5.** ***Cannabis sativa***

***Common name:*** Marijuana, Bhang, Ganja, and Hashish

***Chemical constituents:*** Cannabidiol, Tetrahydrocannabinol, Cannabinoids.

***Pharmacological activities:*** Most of the effects produced by cannabinoids in the nervous system and in non-neural tissues

rely on CB1 receptor activation. In contrast, the CB2 receptor was initially described to be present in the immune system, but was more recently shown to be also expressed in cells from other origins. Notably, expression of the CB1 and CB2 receptors has been found in many types of cancer cells, but not necessarily correlating with the expression of those receptors in the tissue of origin[8,9].

***Distribution:*** It is native to Central Asia, and long cultivated in Asia, Europe, and China. Now it is widespread as tropical, temperate and subarctic cultivar and waif. The oldest use of hemp seems to be for fiber, and later the seeds began to be used for culinary purposes. Plants yielding the drug seem to have been discovered in India, cultivated for medicinal purposes as early as 900 BC. In medieval times it was brought to North Africa where it is now cultivated exclusively for hashish or kif.

6. ***Tabebuia Impetiginosa***

***Common Names:*** Lapacho, Pau D'Arco, Taheebo, and Ipe Roxo

***Chemical constituents:*** Beta-Lapachone, Lapachol Beta-lapachone

***Pharmacological activities:*** Beta-lapachone, one quinone compound from the bark of different Tabebuia trees was reported to have anti-cancer activities. Therefore, extensive investigations were carried out with human cell lines for finding new insights into possible molecular mechanisms. So fl-lapachone inhibits the progression and metastasis of hepatoma cell lines by inhibiting the invasive ability of the cells[10]. In human prostate, carcinoma DU 145 cells lapachone induced inhibition of growth and apoptosis in dose-dependent manner as measured by MTT assay, fluorescent microscopy and flow-cytometry analysis.

***Distribution:*** It is found in the rainforests of South America, especially in Argentina, Paraguay, and Brazil. The Lapacho Tree is an evergreen with blossoms that may be red or purple. It has been proven to be medically useful, even since the time of the Incas.

7. ***Nothapodytes Foetida***

***Common Name:*** Nothapodytes Tree

***Chemical constituents:*** Acetylcamptothecin, Camptothecin, Scopolectin Camptothecin

***Pharmacological activities:*** Camptothecin itself is not used clinically due to its cytotoxicity, but its derivatives are most effective for the treatment of cancer. Interest in camptothecin congeners was renewed when it was reported that 9-aminocamptothecin exhibits curative activity against human colon adenocarcinoma[11]. Camptothecin and its derivatives inhibit the growth of human breast carcinoma cell *in vitro* and induce complete regression of breast tumors[12].

***Distribution:*** It has its medicinal use whose wood-extract is used in treating cancer. This tree is found in Western Ghats, India. This plant has medicinal properties similar to the camptothecin plant, as they have remarkably similar chemical constituents.

**8.** ***Taxus brevifolia***

***Common Name:*** Pacific Yew

***Chemical constituents:*** Taxine, Taxagifine

***Pharmacological activities:*** Various studies have shown that Paclitaxel is effective anticancer agent against lung, breast, ovarian, leukopenia and liver cancer. Paclitaxel has a role in treating various kinds of cancer by targeting tubulin or inducing cell cycle arrest or enhancing the signaling factors or mutating them[13].

***Distribution:*** This coniferous tree is native to Southeast Alaska, it also commonly exists in the western part of the United States.

**9.** ***Catharathus roseus***

***Common Names:*** Madagascar Periwinkle, Periwinkle

***Chemical constituents:*** Vinblastine, Vincristine, Vindesine, Vinorelbine Vinblastine.

***Pharmacological activities:*** The leaves and stems are the sources of dimeric alkaloids, vinacristine and vinblastine that are indispensable cancer drugs. The extracts of Vinca have demonstrated significant anticancer activity against numerous cell types[14].

***Distribution:*** The periwinkle plant is located in the southern portion of North America. Its fruit has an ellipsoid structure with pink or purple shaded petals in its flower.

**10.** ***Alpinia galanga***

***Common names:*** Vacha, Kulanjan

***Chemical constituent:*** Galangin

***Pharmacological activities:*** It possesses significant anticancer activity against cancers of breast, lung, stomach, colon, prostate, multiple myeloma and leukaemia. Pinocembrin isolated from *Alpinia galanga* inhibits growth & spread in colon cancer by arresting cell proliferation and inducing apoptosis[1].

***Distribution:*** It is native to South Asia, Indonesia and cultivated in Malaysia, Laos and Thailand.

**11.** ***Amoora rohituka***

***Common names:*** Rohituka Tree

***Chemical constituents:*** Amooranin

***Pharmacological activities:*** Amooranin (a triterpene acid), isolated from Amoora rohituka inhibits growth & spread of breast and cervical cancers by arresting G2/M phase of the cell cycle and by inducing apoptosis. Amooranin and its derivatives are effective in both chemotherapy-sensitive and chemotherapy resistant cancers. Amooranin has the ability to overcome (reverse) multidrug resistance in breast cancer, colon cancer and leukaemia[1].

***Distribution:*** It is available throughout India in dense evergreen forests

**12.** ***Bauhinia variegata***

***Common names:*** Kanchnar

***Chemical constituents:*** Cyanidin glucoside, malvidin glucoside

***Pharmacological activities:*** Cyanidin glucoside, malvidin glucoside, peonidin glucoside and kaempferol galactoside isolated from Bauhinia variegata inhibit growth & spread of various cancers such as cancers of breast, lung, liver, oral cavity, larynx and malignant ascites. Bauhinia variegata also possesses significant hepatoprotective activity[1].

***Distribution:*** It is native to Southeast Asia, China, Burma, Pakistan, Sri Lanka etc.

**13.** ***Berberis vulgaris***

***Common names:*** Kachnar, Orchid tree

***Chemical constituents:*** Berberine, berbamine, chelidonic acid, citric acid, columbamine, hydrastine, isotetrandrine, jacaranone, magnoflorine, oxycanthine and palmatine.

***Pharmacological activities:*** Berberine (an isoquinoline alkaloid), possesses anticancer, immunoenhancing, antioxidant and antiinflammatory properties. Berberine arrests cancer cell cycle in G1-phase and induces apoptosis. It possesses strong anticancer activity against prostate cancer, liver cancer and leukaemia. Berberine interferes with P-glycoprotein in chemotherapy-resistant cancers. Berberine also increases the penetration of some chemotherapy drugs through the blood-brain barrier, thereby enhancing their effect on intracranial tumours. Cannabisin-G protects against breast cancer. Berberis vulgaris also inhibits growth of stomach and oral cavity cancers[1].

***Distribution:*** It is native to South Asia, Indonesia and cultivated in Malaysia, Laos and Thailand.

**14.** ***Emblica officinalis***

***Common names:*** Amlaki

***Chemical constituents:*** Ellagic acid, gallic acid, quercetin, kaempferol, emblicanin, proanthocyanidin.

***Pharmacological activities:*** It is valued for its unique tannins and flavonoids and possesses powerful antioxidant and anticancer properties. Emblicanin A & B (tannins) possess strong antioxidant and anticancer properties. *Emblica officinalis* inhibits growth & spread of various cancers including that of the breast, uterus, pancreas, stomach, liver and malignant ascites. *Emblica officinalis* protects against cancer, especially, the liver cancer. It also reduces the side effects of chemotherapy & radiotherapy[15].

***Distribution:*** It is grown in Tamil Nadu, Rajasthan and Madhya Pradesh.

**15.** ***Ginkgo biloba***

***Common names:*** Maidenhair Tree

***Chemical constituents:*** Ginkgetin and Ginkgolides (A & B)

***Pharmacological activities:*** Ginkgetin and Ginkgolides (A & B), isolated from Ginkgo biloba inhibits growth and spread of various aggressive cancers such as invasive oestrogen-receptor negative breast cancer, glioblastoma multiforme, hepatocellular carcinoma and cancers of ovary, colon, prostate and liver by inducing apoptosis. *Ginkgo biloba* extract is well known for its antioxidant activity. It also reduces side effects of chemotherapy and radiotherapy[1].

**16.** ***Glycine max***

***Common names:*** Soya

***Chemical constituents:*** Genistein, Daidzein, Quercetin

***Pharmacological activities:*** Isoflavones (such as genistein & daidzein) and saponins isolated from *Glycine max* inhibit growth and spread of various cancers such as cancers of the breast, uterus, cervix, ovary, lung, stomach, colon, pancreas, liver, kidney, urinary bladder, prostate, testis, oral cavity, larynx, and thyroid. Glycine max is also effective in nasopharyngeal carcinoma, skin cancer, malignant lymphoma, rhabdomyosarcoma, neuroblastoma, malignant brain tumours and leukaemia. Isoflavones and saponins isolated from *Glycine max* possess wide ranging anticancer properties such as inhibition of cancer cell proliferation, promotion of cell differentiation and induction of apoptosis. Genistein works by blocking angiogenesis (formation of new blood vessel), acting as a tyrosine kinase inhibitor (the mechanism of action of many new cancer drugs) and inducing apoptosis. Genistein is an excellent intracellular antioxidant. It also blocks the supply of oxygen and nutrients to cancer cells, thus killing them by starving. Genistein and quercetin have synergistic anticancer effect against ovarian carcinoma[1].

**17.** ***Gossypium hirsutum***

***Chemical constituents:*** Gossypol, Gossypolone

***Pharmacological activities:*** Gossypol isolated from Gossypium hirsutum inhibits growth and spread of various cancers such as cancers of the breast, oesophagus, stomach, colon, liver, pancreas, adrenal gland, prostate, urinary bladder, malignant lymphoma, malignant ascites, brain tumours, sarcomas and leukaemia by inducing apoptosis and arresting cancer cell

division in G0/G1 phase. The negative isomer of gossypol, (-) gossypol, inhibits growth and spread of chemotherapy and radiotherapy-resistant cancers of prostate, breast, ovary, lung, pancreas, head and neck and brain by inducing apoptosis. Gossypolone, oxidative metabolite of gossypol, inhibits growth and spread of various cancers including that of the breast, cervix, lung, malignant melanoma and leukaemia[1].

**18.** ***Morinda citrafolia***

***Chemical constituents:*** Damnacanthol

***Pharmacological activities:*** Damnacanthol, NB10 and NB11 isolated from Morinda citrifolia possess strong anticancer activity against various cancers particularly lung cancer and sarcomas. Morinda citrifolia, possesses strong antioxidant, hepatoprotective and immunoenhancing properties[16].

**19.** ***Nigella sativa***

***Common names:*** Kalajeera

***Chemical constituents:*** Thymoquinone and dithymoquinone

***Pharmacological activities:*** Thymoquinone and dithymoquinone isolated from Nigella sativa have strong anticancer activity against various cancers including cancers of the colon, prostate, pancreas, uterus, malignant ascites, malignant lymphoma, malignant melanoma, sarcomas and leukaemia. Thymoquinone is effective in both hormone-sensitive and hormone refractory prostate cancer. Nigella sativa kills cancer cells by binding to the asialofeutin (lectin) on the surface of cancerous cells, causing their aggregation and clumping. Nigella sativa also possesses immunoenhancing and anti-inflammatory properties. It protects against liver cancer. Nigella sativa enhances immune function of the body and reduces side effects of chemotherapy and radiotherapy[1].

**20.** ***Panax ginseng***

***Chemical constituents:*** Ginsenosides

***Pharmacological activities:*** Ginsenosides (panaxadiol and panaxatriol saponins) isolated from Panax ginseng inhibits growth and spread of various cancers such as cancers of breast, ovary, lung, prostate, colon, renal cell carcinoma, malignant melanoma, malignant lymphoma and leukaemia. Ginsenosides possesses strong anticancer activity against lung cancer and also

prevents lung metastasis by blocking angiogenesis. Compound K (a metabolite of ginsenosides) inhibits growth and spread of chemo-resistant lung cancer. Ginsenosides Rc, Rd, Rg1 and Re-overcome (reverse) P-glycoprotein mediated multidrug resistance to chemotherapy. Ginsenoside Rf helps in reducing doses of morphine in terminally ill cancer patients[17].

**21.** ***Ocimum sanctum***

***Common names:*** Tulsi

***Chemical constituents:*** Eugenol, Linolenic acid, Rosmarinic acid and flavonoids such as orientin, vicenin, apigenin.

***Pharmacological activities:*** Active constituents such as Eugenol, orientin and vicenin inhibit growth and spread of various cancers such as breast cancer, liver cancer and sarcomas particularly fibrosarcoma by blocking supply of oxygen and nutrients to the cancer cells and killing them by starving. It has antioxidant and radioprotective properties, protects against various cancers particularly the breast cancer and reduces side effects of chemotherapy and radiotherapy[1].

**22.** ***Plumbago zeylanica***

***Common names:*** Chitrak

***Chemical constituents:*** Plumbagin

***Pharmacological activities:*** Plumbagin inhibits growth and spread of breast cancer, liver cancer, fibrosarcoma, malignant ascites and leukaemia by inhibiting cancer cell proliferation[1].

**23.** ***Podophyllum hexandrum***

***Chemical constituents:*** Podophyllotoxin, Podophyllin

***Pharmacological activities:*** Podophyllotoxin and podophyllin (lignans) isolated from Podophyllum hexandrum (Himalayan May Apple) inhibit growth and spread of various cancers including that of the breast, ovary, lung, liver, urinary bladder, testis, brain, neuroblastoma, Hodgkin's disease, nonHodgkin's lymphoma and leukaemia. Podophyllotoxin is the most active among all the natural anticancer compounds[1].

**24.** ***Rubia cordifolia***

***Common names:*** Manjistha

***Chemical constituents:*** Rubianin, Rubiadin

***Pharmacological activities:*** Rubidianin, rubiadin, RA-7, RA-700 and RC-18 isolated from Rubia cordifolia inhibit growth and spread of cancers of breast, ovary, cervix, colon, lung, malignant ascites, malignant lymphoma, malignant melanoma sarcoma and leukaemia[18].

**25.** ***Saussurea lappa***

***Chemical constituents:*** Cynaropicrin

***Pharmacological activities:*** Sesquiterpenes and costunolide dehydro-costuslactone, isolated from Saussurea lappa inhibit growth and spread of breast cancer. Cynaropicrin, isolated from Saussurea lappa possesses strong anticancer activity against malignant lymphoma and leukaemia. Costunolide, isolated from Saussurea lappa inhibits growth and spread of intestinal cancer. Mokkolactone isolated from Saussurea lappa induces apoptosis in leukaemic cells. Shikokiols isolated from Saussurea lappa exhibits anticancer activity against cancers of the ovary, lung, colon and central nervous system[1].

**26.** ***Solanum nigrum***

***Chemical constituents:*** Solamargine, Solasonine

***Pharmacological activities:*** Solamargine and solasonine, isolated from Solanum nigrum (Lo-ing-kue) inhibit growth and spread of various cancers including that of the breast, liver and lung. Steroidal glycosides (spirostane, furostane, spirosolane and pregnane), isolated from *Solanum nigrum* inhibit growth and spread of colon cancer and pheochromocytoma. Glycoproteins isolated from *Solanum nigrum* have antiproliferative and apoptotic effects on colon and breast cancers[19]. Polysaccharides isolated from *Solanum nigrum* have significant inhibitory effect on growth of cervical cancer.

**27.** ***Tinospora cordifolia***

***Common names:*** Guduchi

***Chemical constituents:*** Tinosporaside

***Pharmacological activities:*** Sesquiterpenes obtained from this plant alleviates spread of various cancers including that of lung, cervix, throat and malignant ascites. Polysaccharide fraction isolated from *Tinospora cordifolia* inhibits lung metastasis[20].

**28.** ***Andrographis paniculata***

***Common name:*** Kalmegh

***Chemical constituent:*** Andrographolide

***Pharmacological activities:*** Andrographolide, active diterpine component, isolated from Andrographis paniculata, has immunoenhancing and strong anticancer activity against cancers of breast, ovary, stomach, colon, prostate, kidney, nasopharynx malignant melanoma and leukaemia. Andrographolide exerts direct anticancer activity on cancer cells by arresting G0/G1 phase of cell-cycle and inducing apoptosis[1].

***Distribution:*** It is found throughout India.

**29.** ***Glycyrrhiza glabra***

***Common name:*** Shankhapushpi

***Chemical constituent:*** Glycyrrhizin

***Pharmacological activities:*** Flavonoids (flavones, flavonals, isoflavones, chalcones, licochalcones and bihydrochalcones), derived from Glycyrrhiza glabra possess strong anticancer, antioxidant, antimutagenic, antiulcer, anti-HIV and hepatoprotective properties[1].

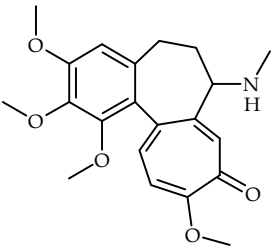
**30.** ***Psoralea corylifolia***

***Common name:*** Bavchi

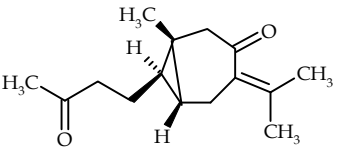
***Chemical constituents:*** Bavachinin, corylfolinin and psoralen

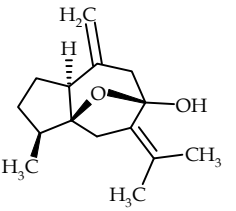
***Pharmacological activities:*** Bavachinin, corylfolinin and psoralen isolated from Psoralea corylifolia (Bu Gu Zhi), possess strong anticancer activity against lung cancer, liver cancer, osteosarcoma, fibrosarcoma, malignant ascites and leukaemia. Psoralen enhances immunity of the body by stimulating natural killer cell activity. Psoralidin isolated from Psoralea corylifolia inhibits growth and spread of stomach and prostate cancers by inhibiting G2/M phase of cell cycle[1].

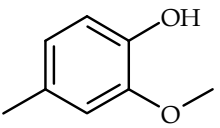
## Chemical Structures of Anti cancer plants



Demecolcine

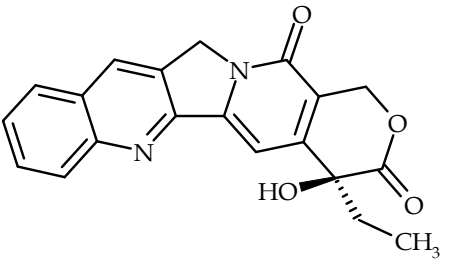


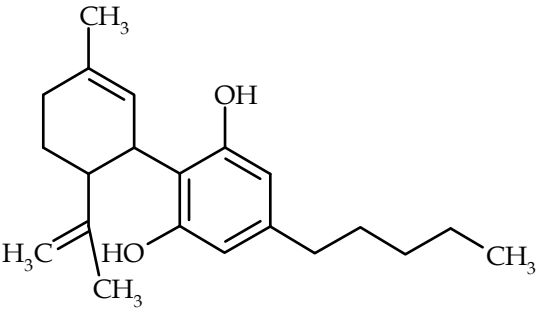




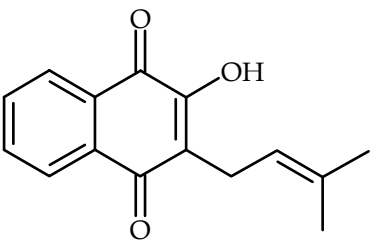
Creasol

Camptothecin

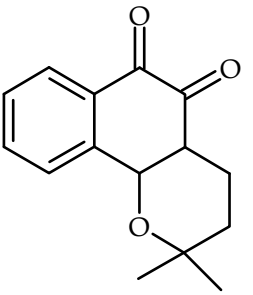




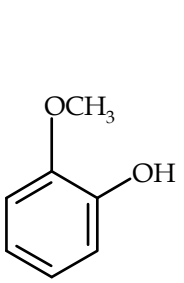
Cannabidiol

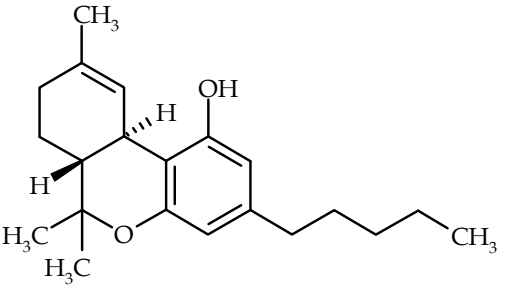


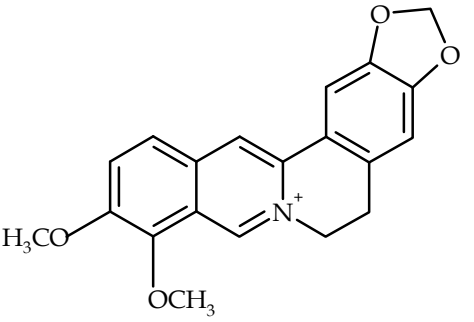
Lapachol

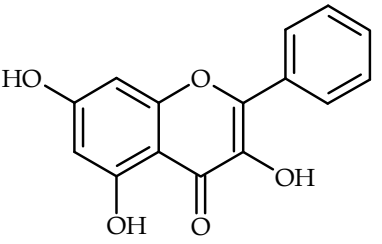


Beta-Lapachone

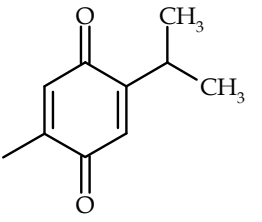


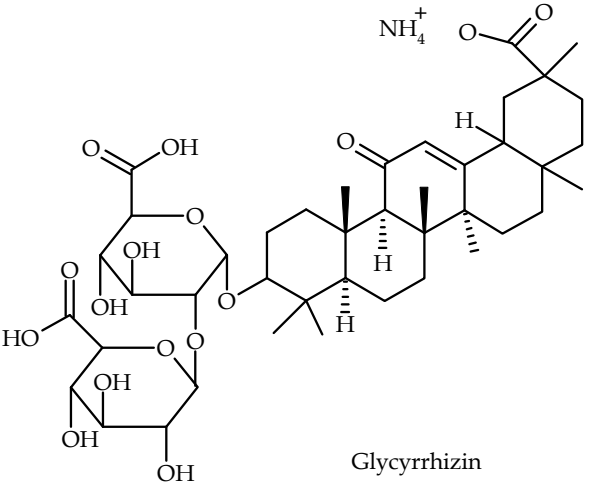



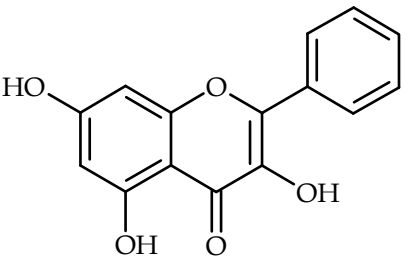

Berberine



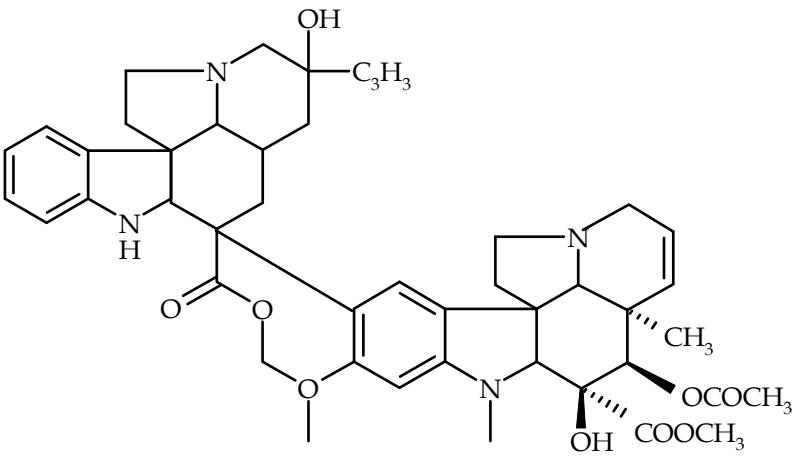

Thymoquinone



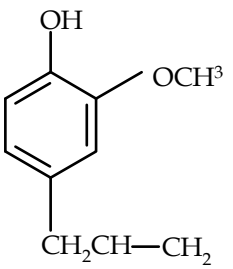

Glycyrrhizin



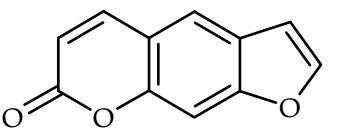

Berberine

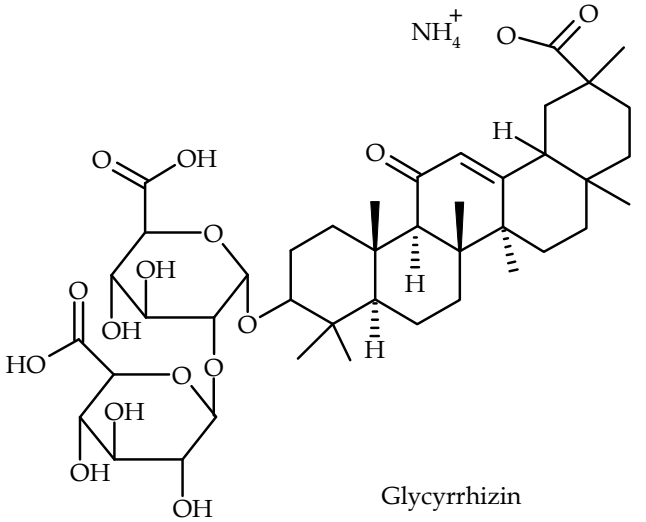



Vinblastine

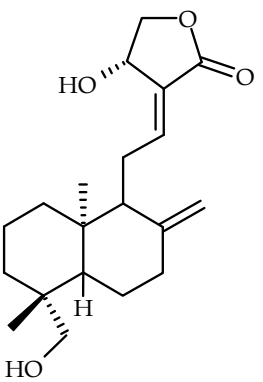



Eugenol

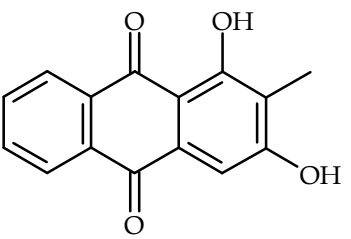


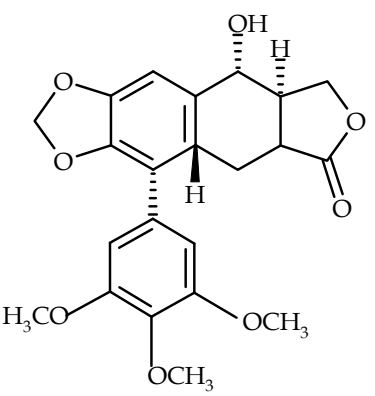



Glycyrrhizin

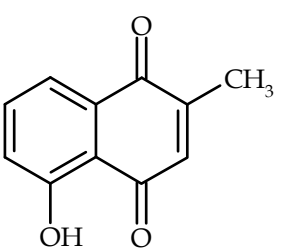


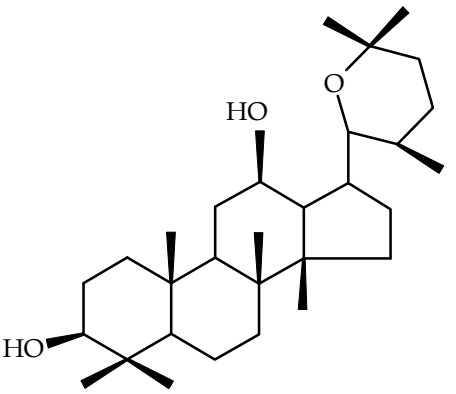

Andrographolide



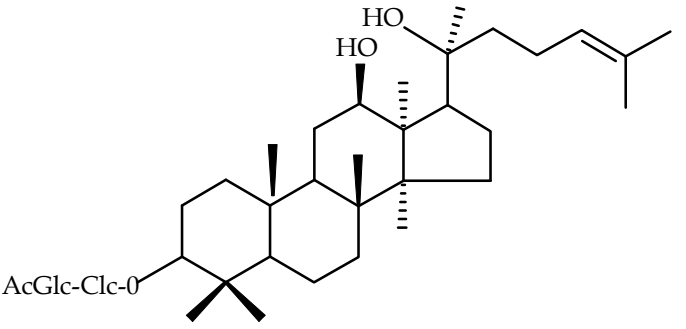




Rubiadin

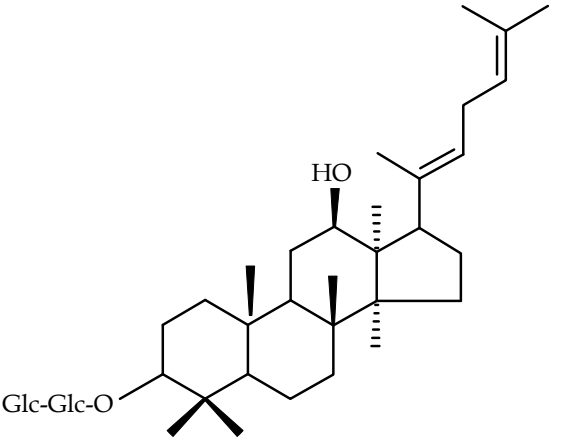





Panaxadiol (aglycone)




Ginsenoside-R3 (G-re3)




Ginsenoside-Rg5 (G-Rg5)

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