



"A Comprehensive Overview of Cancer Disease: Insights into Diagnosis, Treatment, and Beyond"

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Abstract:

The aim is to provide an overview of recent breakthroughs in cancer therapies and their potential impact on patient care. The article also highlights emerging technologies in clinical trials, some of which have already been approved for use. Cancer refers to over 277 different types of diseases. Scientists have discovered that cancer develops through various stages, and several gene mutations contribute to its growth. These mutations cause cells to grow abnormally. Inherited genetic factors play an important role in the increase of cell growth. Thanks to advances in technology, like bioinformatics and molecular techniques, we now have more information that helps with early diagnosis and better treatment options. Understanding how drugs affect cancer patients can also help predict and manage some side effects. Targeted therapy has shown great promise in stopping the growth and spread of specific cancer cells, while causing less harm to healthy cells. Ablation therapy is a new, less invasive treatment that destroys cancer cells by either freezing or burning them, without the need for surgery. Natural antioxidants have shown potential in fighting cancer by neutralizing harmful free radicals. Many new treatments are being tested in clinical trials, and some have already been approved. This review highlights the latest progress and breakthroughs in cancer treatments.

Keywords: Cancer growth stages, Inherited genetic factors, Bioinformatics, Molecular techniques, Early diagnosis.

Introduction:-

Cancer is a broad term for a group of over 100 diseases that occur when cells in the body grow and divide uncontrollably.. Normally, cells follow specific rules for growth and division, but in cancer, a cell starts to ignore these rules and grows without control. The number of cancer cases has actually increased, and in the United States alone, about 1,665,540 people were diagnosed with cancer, and 585,720 of them died from it in 2014. This makes cancer a serious health issue affecting people all over the world. Unfortunately, cancer is a very diverse disease at the tissue level, and this diversity makes it difficult to diagnose accurately and treat effectively. In men, the most common types of cancer are found in the prostate, lungs and bronchi, colon and rectum, and urinary bladder. Cancer is a condition caused by genetic or epigenetic changes in somatic cells, leading to abnormal cell growth that can spread to other parts of the body. It forms a type of neoplasm, where cells grow uncontrollably, creating a lump or mass that may spread widely. It was predicted that by 2025, there will be around 420 million new cases of cancer annually, showing an increase in cancer incidence over the years. In 2018, there were about 18 million cancer cases worldwide, with 9.5 million in men and 8.5 million in women.

Epidemiology:-

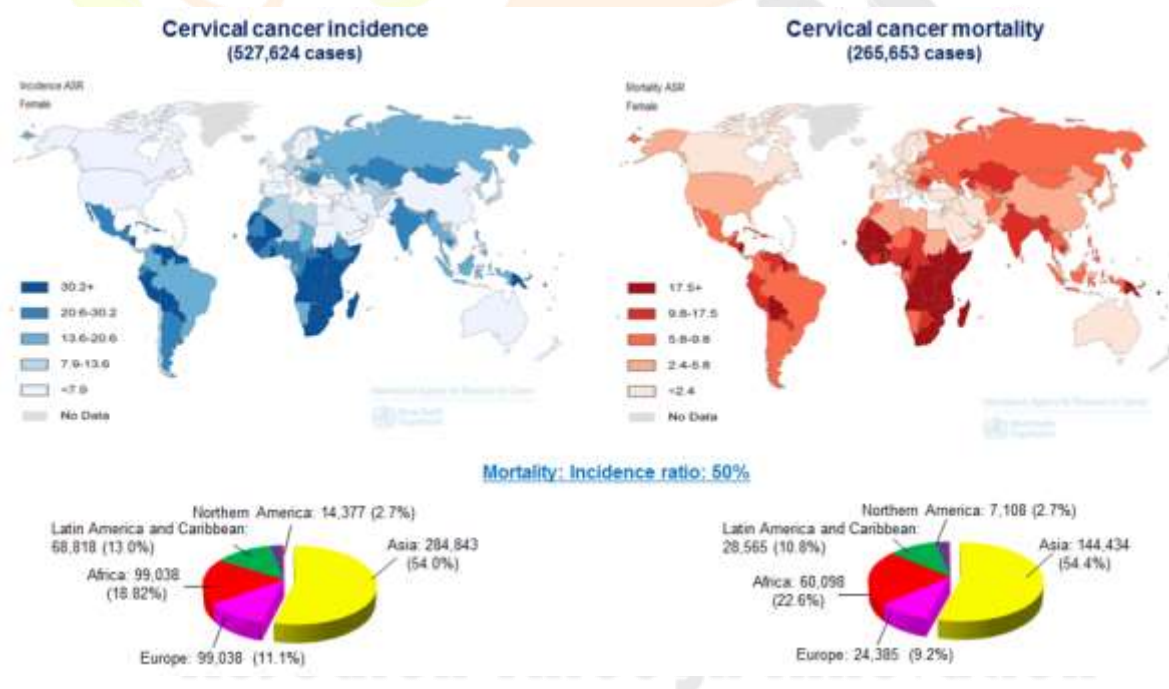
In 2016, there were around 1.7 million new cancer cases in the United States. For women, the most common types of cancer were breast, lung, colon, uterine, and thyroid cancers. For men, the most common cancers were prostate, lung, colon, bladder, and skin melanoma.

Even though treatments have improved, cancer is still the second leading cause of death in the U.S., with about 1,630 people dying from cancer every day. Lung and bronchus cancers are responsible for about a quarter of all cancer deaths, making them the leading cause of cancer-related death for both men and women.

Worldwide, cancer rates are rising. The World Health Organization (WHO) predicts that the number of new cancer cases will increase by about 70% in the next 20 years. In developing countries, cancers linked to viral infections, like liver cancer (from hepatitis) and cervical cancer (from HPV), are more common.

A healthy lifestyle can prevent about one-third to one-half of cancers. This includes avoiding tobacco, keeping a healthy weight, limiting alcohol, and staying active. Other important research areas include the effects of infections and hormones on cancer risk, though factors like radiation, environment, and genetics also play a role.

Thanks to early detection and better treatments, survival rates have improved. In 2016, there were around 15.5 million cancer survivors in the U.S., and this number is expected to grow to more than 20 million by 2025. The largest groups of survivors were those who had breast, prostate, colon, uterine, or melanoma cancers. Cancer survivorship is becoming an important public health issue, as survivors face challenges like the risk of cancer coming back and long-term effects of treatment. However, many survivors may be more open to changing their lifestyle to improve their health, especially if it could help prevent the cancer from returning.



Need for the study:-

Cancer is a major health problem in both rich and poor countries, and it is one of the leading causes of illness and death worldwide. India has the largest number of cancer patients. For a country like India, focusing on preventing cancer and finding it early is more important than discovering new drugs. This evaluation will be a helpful resource for scientists, funding organizations, and government efforts to focus resources on improving local cancer research and developing public health

2. Finding Cancer Early & Preventing It – When cancer is found early, it is easier to treat. Scientists research ways to detect it sooner and prevent it from happening, so more people can stay healthy and live longer.

3. **Better Treatments** – Cancer treatments are improving because of research. New methods like targeted therapy and immunotherapy help treat cancer more effectively with fewer side effects, making it easier for patients to recover.

4. **Saving More Lives** – Many people die from cancer, but with better treatments and early detection, more lives can be saved. Research helps doctors find ways to stop cancer from spreading and make treatments more successful.

5. **Lowering Costs & Helping Families** – Cancer treatment can be very expensive and stressful for families. Research helps find ways to make treatments more affordable and effective, reducing the financial and emotional burden on patients and their loved ones.

6. **Improving Life for Patients** – Cancer can be a difficult disease to live with. Research helps doctors provide better care and support, making life easier for patients during and after treatment.

7. **Helping Other Medical Discoveries** – Cancer research also benefits other areas of medicine. Scientists learn more about genetics, the immune system, and new technologies, which can help treat other diseases too.

Objective:-

1. **Growth trend of cancer literature in India:**

- See how cancer research in India has changed over time. Is it growing or shrinking?

2. **Authorship patterns:**

- Find out who is writing the cancer research articles in India. Are they written by one person or by many people together?

3. **Degree of author collaboration:**

- Check how often authors work together on research papers. Do they mostly work alone, or do they team up with others?

4. **Co-authorship patterns and author productivity:**

- Look at how many authors are involved in each article and how many papers each author writes.

5. **Average length of the articles:**

- See how long the cancer research papers are on average. Are they getting longer or shorter?

6. **Research activities of other countries and collaboration:**

- Compare cancer research in India with what other countries are doing and look at how much India works with researchers from other countries.

Types:-

1. Based on the Type of Tissue Affected:

Carcinomas – These cancers start in the cells that cover the inside and outside of the body, like the skin and the lining of organs. Examples: Lung, breast, and colon cancer.

Sarcomas – These cancers grow in bones, muscles, fat, and other supporting tissues of the body.

Lymphomas – These begin in the immune system, especially in the lymph nodes.

Leukemias – These cancers start in the bone marrow, affecting the blood.

Adenomas – These come from glandular tissues like the thyroid, pituitary, and adrenal glands.

2. Based on the Organ Affected:

Colorectal Cancer – Affects the colon or rectum. **Lung Cancer** – Affects the lungs.

Liver Cancer – Affects the liver.

Stomach Cancer – Affects the stomach.

Bladder Cancer – Affects the bladder.

Esophageal Cancer – Affects the tube that carries food from the mouth to the stomach.

Non-Hodgkin Lymphoma – A type of cancer in the immune system.

Lip and Oral Cancer – Affects the lips and mouth.

Nasopharyngeal Cancer – Affects the area behind the nose and above the throat.

Kaposi Sarcoma – A rare cancer that forms in the skin, mouth, or internal organs, often linked to weakened immune systems.

Causes:-

Causes of Cancer: Cancer develops when normal cells in the body grow uncontrollably. Normally, cells divide when needed and die when they are no longer necessary. However, cancer occurs when this process goes wrong—cells either multiply too rapidly or fail to die as they should. There are many types of cancer, which can affect nearly any organ or tissue, such as the lungs, colon, breast, skin, bones, or nervous system. Common causes of cancer include: Exposure to chemicals like benzene Excessive alcohol consumption Environmental toxins, such as poisonous mushrooms or aflatoxins (toxins that grow on certain crops like peanuts)

Prolonged exposure to sunlight

Genetic mutations

Obesity

Viruses

1. Genetic Causes (Inherited or Random DNA Changes) Some people are born with faulty genes that make them more likely to get cancer. For example: BRCA1 and BRCA2 mutations increase the risk of breast and ovarian cancer. Other people may develop cancer due to random DNA mistakes that happen over time. Changes in how genes work (called epigenetic changes) can also contribute to cancer.

2. Environmental and Workplace Exposures The environment around us can contain harmful substances that increase cancer risk, such as: Radiation exposure – Sunlight (UV rays) can cause skin cancer, while X-rays and nuclear radiation can damage DNA.

Toxic chemicals – Smoking, asbestos, and industrial chemicals like benzene can lead to lung and other cancers.

Air pollution – Tiny harmful particles in the air can contribute

3. Lifestyle and Daily Habits Some everyday choices can increase the risk of cancer: Smoking and tobacco use – One of the biggest causes of lung, throat, and mouth cancer. Unhealthy diet – Eating a lot of processed meat and fast food while avoiding fruits and vegetables can increase cancer risk.

Drinking alcohol – Too much alcohol can cause liver, breast, and esophageal LK cancer.

Lack of exercise and obesity – Being overweight and not being physically active can lead to breast, colon, and pancreatic cancer.

4. Viruses and Infections Some infections can damage DNA and lead to cancer, such as: HPV (Human Papillomavirus) – A common virus that can cause cervical, throat, and other cancers.

Hepatitis B and C – These viruses can cause liver cancer.

H. pylori bacteria – This infection increases the risk of stomach cancer. Epstein-Barr virus (EBV) – Can lead to certain blood cancers.

5. Hormones and Their Effects Hormones play a role in some types of cancer: Estrogen (female hormone) – Long-term hormone therapy or birth control pills may increase the risk of breast and uterine cancer.

Testosterone (male hormone) – Higher levels may be linked to prostate cancer.

Symptoms:-

Dyspnea, or difficulty breathing, is a common symptom in cancer patients, particularly at emergency departments like the University Of Texas M.D. Anderson Cancer Center, where it was found to be the fourth most common symptom. The most frequent cancers seen in this group were breast and lung cancer. Most patients had received prior treatments, and nearly 70% had progressive disease. Treatments provided in the emergency department included oxygen, beta-2 agonists, antibiotics, and opioids. The prognosis for patients with dyspnea depends on the type of cancer. For example, patients with lung cancer had a median survival of just 4 weeks, while patients with other cancers had a median survival of more than 20 weeks. Dyspnea can result from cancer itself, treatments like chemotherapy or radiation, or other diseases such as heart failure or chronic obstructive pulmonary disease. It can also be linked to symptoms like cachexia (severe weight loss) or asthenia (weakness). Treatments to manage dyspnea include oxygen, opioids, and sometimes radiation or chemotherapy. However, benzodiazepines have not been proven effective.

Fatigue is another common and distressing symptom for cancer patients. It affects 60-75% of patients with advanced cancer and can be severe in 10-60% of cases. Fatigue may result from the cancer itself, treatments like chemotherapy, radiation, or surgery, or other factors such as sleep problems, environmental conditions, or poor nutrition. It can be associated with psychological distress and reduced functional status. Severe fatigue is often related to pain and dyspnea. While there are no definitive treatments, some doctors use stimulants like methylphenidate to help manage fatigue, though there is little evidence from controlled trials to confirm its effectiveness.

Depression is also common among cancer patients, affecting 25% with some form of depressed mood, and 10-15% may have major depression. Depression is especially common in patients with advanced stages of cancer, such as lung and pancreatic cancer. It is often associated with pain, impaired function, and other factors like socioeconomic status. While antidepressants can help, studies on their effectiveness in cancer patients are limited.

Pain is another significant issue for cancer patients, particularly those with advanced disease. Between 60% and 80% of terminal cancer patients require pain management, but many patients with cancer experience pain at various stages of their disease. Tumor-related pain is the most common cause, often due to invasion of bone, nerves, or other tissues. Other pain can result from surgery, chemotherapy, or radiation. Persistent pain is a common problem for patients with metastatic cancer, affecting their quality of life.

Diagnosis :-

To diagnose cancer, doctors use several methods:

1. **Physical Exam:** The doctor may check your body for lumps or any unusual changes, like skin colour changes or swollen organs, that might suggest cancer.
2. **Laboratory Tests:** Blood and urine tests help find signs of cancer. For example, a blood test called a complete blood count (CBC) can show if there are unusual levels of white blood cells, which is common in leukemia.
3. **Imaging Tests:** These tests let doctors look at your bones and organs without surgery. Tests like CT scans, MRIs, X-rays, or ultrasounds help find possible tumors or abnormalities.
4. **Biopsy:** In this procedure, the doctor takes a small sample of tissue from the area of concern to test it. Normal cells are organized and similar, while cancer cells are disordered and vary in size and shape.

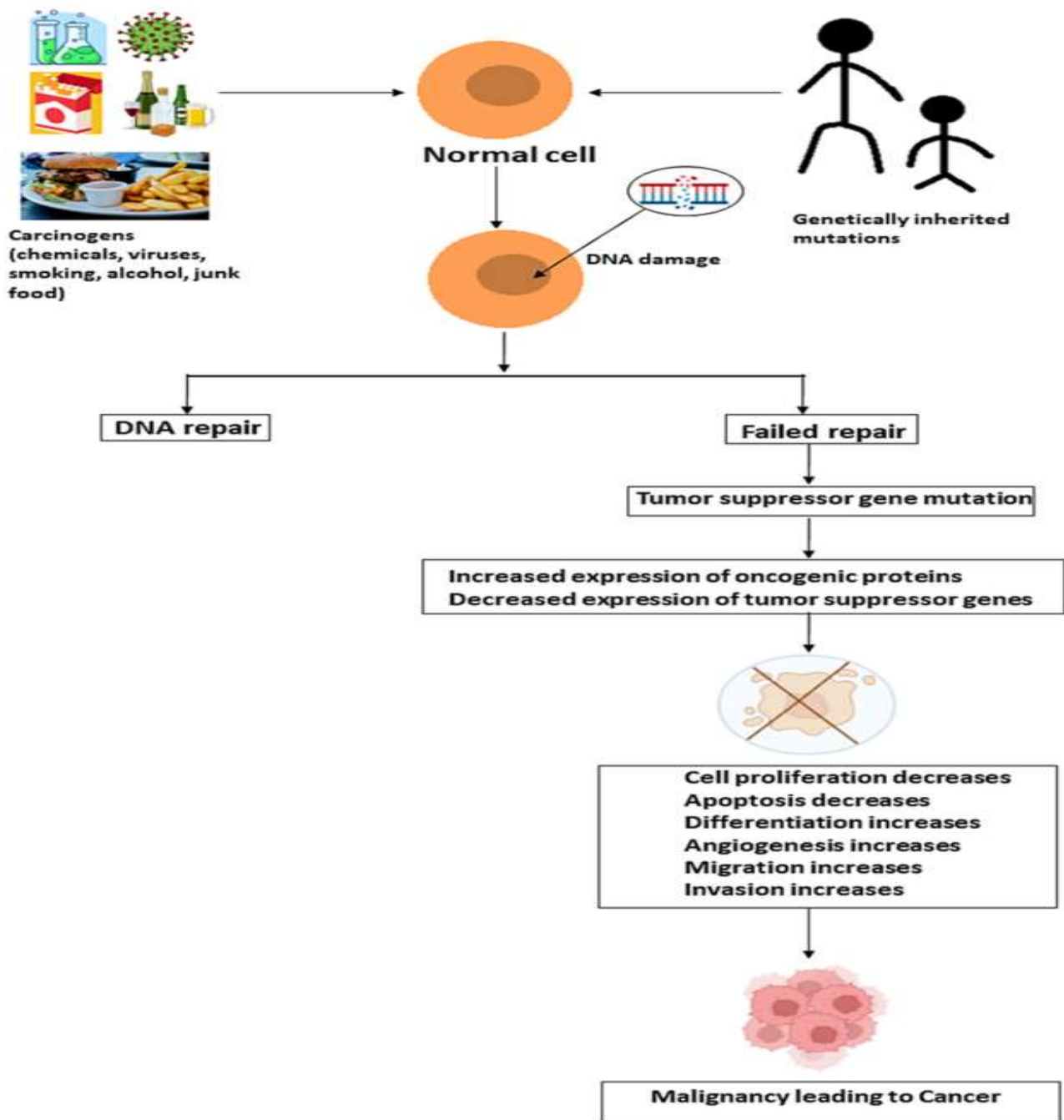
Treatment:-

Cancer treatments can be grouped into two main categories: traditional (or conventional) treatments and modern (or advanced) treatments. Right now, over half of the medical trials happening around the world are focused on finding better ways to treat cancer. The type of cancer, where it is located, and how severe it is help doctors choose the right treatment plan and track its progress. Traditional treatments include surgery, chemotherapy, and radiation. On the other hand, modern treatments include hormone therapy, treatments that block the growth of blood vessels that feed the cancer (anti-angiogenic), stem cell therapies, immunotherapy, and dendritic cell-based immunotherapy. change in another format



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Mechanism of Action:-



Classification of cancer:-

Category	Subcategory	Description	Common Sites
1. Classification by Tissue of Origin	Carcinoma	Originates in epithelial tissue (skin, glands, and linings of organs).	Lungs, breast, colon, prostate, pancreas
	Subtypes	- <i>Adenocarcinoma</i> : Glandular tissues. - <i>Squamous Cell Carcinoma</i> : Squamous epithelial cells.	
	Sarcoma	Originates in connective tissues (bone, cartilage, and muscle, fat).	Bone, muscle, fat, cartilage
	Subtypes	- <i>Osteosarcoma</i> : Bone tissue. - <i>Chondrosarcoma</i> : Cartilage	

		tissue. - <i>Rhabdomyosarcoma</i> : Muscle tissue.	
	Leukemia	Originates in blood-forming tissues (bone marrow).	Blood, bone marrow, lymph nodes
	Subtypes	- <i>Acute Myeloid Leukemia (AML)</i> . - <i>Chronic Myeloid Leukemia (CML)</i> . - <i>Acute Lymphoblastic Leukemia (ALL)</i> . - <i>Chronic Lymphoblastic Leukemia (CLL)</i> .	
	Lymphoma	Originates in lymphatic system (lymph nodes, spleen).	Lymph nodes, spleen, bone marrow
	Subtypes	- <i>Hodgkin's Lymphoma</i> . - <i>Non-Hodgkin's Lymphoma</i> .	
	Melanoma	Originates in pigment-producing cells (melanocytes).	Skin, eye, mucous membranes
	Subtypes	- <i>Superficial spreading melanoma</i> . - <i>Nodular melanoma</i> . - <i>Lentigo maligna melanoma</i> .	
	Glioma	Originates in glial cells (brain and spinal cord supportive cells).	Brain, spinal cord
	Subtypes	- <i>Astrocytoma</i> . - <i>Oligodendroglioma</i> . - <i>Ependymoma</i> .	
	Neuroblastoma	Originates in nerve cells, often in the adrenal glands.	Abdomen, neck, pelvis
	Subtypes	- <i>Ganglioneuroblastoma</i> . - <i>Neuroblastoma</i> .	
2. Classification by Location	Breast Cancer	Originates from the epithelial cells of the breast tissue.	Breast
	Lung Cancer	Originates in lung tissues.	Lungs
	Colon Cancer (Colorectal Cancer)	Originates in the colon or rectum.	Colon, rectum
	Prostate Cancer	Originates in the prostate gland.	Prostate
	Pancreatic Cancer	Originates in the pancreas.	Pancreas
	Skin Cancer	Affects skin cells.	Skin
	Subtypes	- <i>Basal Cell Carcinoma</i> . - <i>Squamous Cell Carcinoma</i> . - <i>Melanoma</i> .	
3. Classification by Staging	Stage 0	Carcinoma in situ, localized to the site of origin and has not spread.	
	Stage I	Cancer is small and localized, treatable.	
	Stage II	Cancer has spread to nearby tissues or lymph nodes but is still contained.	
	Stage III	Cancer has spread extensively	

		to nearby structures and lymph nodes.	
	Stage IV	Cancer has spread to distant organs or other parts of the body.	
4. Classification by Molecular & Genetic Characteristics	Oncogenes	Genes that have the potential to cause cancer when mutated.	
	Tumor Suppressor Genes	Genes that protect cells from cancer; when mutated, cancer can develop (e.g., TP53).	
	Genetic Mutations	Specific mutations (e.g., BRCA1/2 in breast cancer) guide treatment and risk assessment.	
	Hormone Receptors	Some cancers (e.g., breast cancer, prostate cancer) have hormone receptors, affecting growth and treatment options.	
	Gene Expression Profiling	Analyzing gene expression to predict cancer behaviour and response to treatment.	
5. Cancer Grading	Grade I	Cancer cells look similar to normal cells and tend to grow slowly.	
	Grade II	Cancer cells look more abnormal and grow faster than Grade I.	
	Grade III	Cancer cells look very abnormal and grow rapidly.	
	Grade IV	Cancer cells are extremely abnormal and are likely to spread quickly.	
6. Other Classifications	Benign vs. Malignant	- Benign: Non-cancerous tumors that do not spread. - Malignant: Cancerous tumors that spread and invade other tissues.	
	Solid Tumors vs. Hematologic Cancers	- Solid Tumors: Affect solid organs or tissues (e.g., breast, lung, and colon). - Hematologic Cancers: Affect blood or lymphatic systems (e.g., leukemia, lymphoma).	Solid organs (e.g., breast, lung, colon), blood/lymphatic systems (e.g., leukemia, lymphoma)

Transmission:-

1. Is Cancer Contagious?

Cancer is not contagious in the way that illnesses like the flu or COVID-19 are. You cannot catch cancer from someone else by touching them or being around them. However, there are a few rare situations where cancer cells can be passed from one person to another:

Organ Transplants:

In very rare cases, cancer can be passed during organ transplants. This happens if the organ donor had cancer that was not detected at the time of donation. The transplant recipient, especially if they have a weakened immune system (due to medications), may not be able to fight off the cancer cells from the donor (Petrini et al., 2009).

Pregnancy and Childbirth:

Sometimes, cancer can be passed from a mother to her baby during pregnancy, but this is very rare. Certain cancers, like melanoma or leukemia, have been reported to transfer from the mother to the foetus through the placenta (Tchirkov et al., 2011). The reasons for this are not fully understood, and it is an extremely uncommon occurrence.

2. Infectious Agents that Contribute to Cancer

Although cancer itself isn't contagious, certain viruses and bacteria can increase the risk of developing cancer. These infections can cause changes in the DNA of cells or weaken the immune system, making it easier for cancer to develop.

Human Papillomavirus (HPV):

HPV is a virus that is spread through sexual contact. Some types of HPV, especially types 16 and 18, can cause changes in the cells of the cervix, leading to cervical cancer. HPV can also increase the risk of other cancers, like anal, throat (**or** pharyngeal), and penile cancers (Schiffman et al., 2011).

Hepatitis Viruses (B and C):

Both Hepatitis B (HBV) and Hepatitis C (HCV) are viruses that can lead to liver cancer. These viruses are usually spread through contact with infected blood or bodily fluids. Chronic infection can cause long-term liver damage, including cirrhosis, and can eventually lead to liver cancer (El-Sera, 2012).

Human Immunodeficiency Virus (HIV):

HIV itself doesn't directly cause cancer, but it weakens the immune system. This makes it harder for the body to fight off infections that can lead to cancer. People with HIV are more likely to develop cancers like Kaposi's sarcoma and non-Hodgkin lymphoma, especially if they also have other infections like HPV or Epstein-Barr virus (Dittmer et al., 2010).

3. Genetic Factors in Cancer

Cancer is not passed directly from one person to another, but genetics can play a big role in whether someone is more likely to develop certain types of cancer. Some people inherit genetic mutations (changes in their DNA) from their parents that make them more likely to get specific cancers.

Hereditary Cancer Syndromes:

Some well-known genetic mutations, like the BRCA1 and BRCA2 genes, increase the risk of cancers such as breast and ovarian cancer. If a person inherits these mutations, they may have a higher chance of developing cancer at a younger age. Another example is Lynch syndrome, a genetic condition that raises the risk of colorectal and endometrial (uterine) cancers. These genetic traits can be passed from parents to their children (Miki et al., 1994).

4. Environmental and Lifestyle Factors in Cancer

Along with genetic factors, cancer can also be influenced by environmental exposures and lifestyle choices. Here are a few key factors that can increase cancer risk:

Carcinogens:

Some substances, like tobacco smoke, asbestos, and ultraviolet (UV) radiation from the sun, can directly cause cancer. These harmful substances damage the DNA in our cells, leading to changes that may eventually result in cancer (IARC, 2012).

Obesity:

Being overweight or obese can increase the risk of several types of cancer, such as **breast**, colorectal, and pancreatic cancer. This is partly because excess weight leads to higher levels of insulin and inflammation in the body, both of which can contribute to cancer development (Chuang et al., 2013).

5. Tumor Microenvironment and Cancer Progression

The tumor microenvironment is the area around a Tumor, including surrounding cells, blood vessels, and immune cells. This environment plays a big role in how cancer grows and spreads.

One important process in cancer progression is metastasis, which is when cancer cells spread from the original Tumor to other parts of the body. It's not "transmission" like catching a virus, but rather the cancer cells' ability to invade the bloodstream or lymphatic system, travel to different organs, and form new tumors (Hanahan & Weinberg, 2011).

6. Emerging Research on Cancer Transmission

New research is looking into how cancer might spread in ways we didn't fully understand before. One interesting area of study involves exosomes. These are tiny particles that are released by cancer cells. Researchers believe exosomes might help cancer cells communicate with each other and with the surrounding tissue. This communication could help cancer cells grow and spread more easily (Liu et al., 2015).

Conclusion:-

Cancer remains a complex and challenging disease, but recent advancements in research and treatment offer promising prospects for improved outcomes. Targeted therapies and minimally invasive treatments, such as ablation therapy, have significantly enhanced the precision and effectiveness of cancer care while minimizing harm to healthy tissues. Additionally, the potential of natural antioxidants in cancer prevention and treatment continues to be explored. On going research and clinical trials are driving innovation in cancer therapies, leading to new treatment options and better management of side effects. As technology and scientific understanding evolve, the future of cancer treatment looks increasingly optimistic, with the potential to improve survival rates and quality of life for patients worldwide. Cancer is a multifaceted disease with a range of treatment options continuing to evolve. While traditional therapies like chemotherapy and radiation remain vital, the development of more precise and targeted treatments offers hope for better outcomes with fewer side effects. Breakthroughs in immunotherapy, where the body's immune system is harnessed to fight cancer, and gene therapy, which targets genetic mutations, are paving the way for more personalized treatments. Moreover, advancements in early detection, aided by new technologies and biomarkers, have the potential to identify cancer at earlier, more treatable stages. While challenges remain, the rapid progress in cancer research provides a strong foundation for future innovations, making cancer treatment increasingly effective and accessible. Continued collaboration and research will be key to making further strides in understanding and combating this complex disease.

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