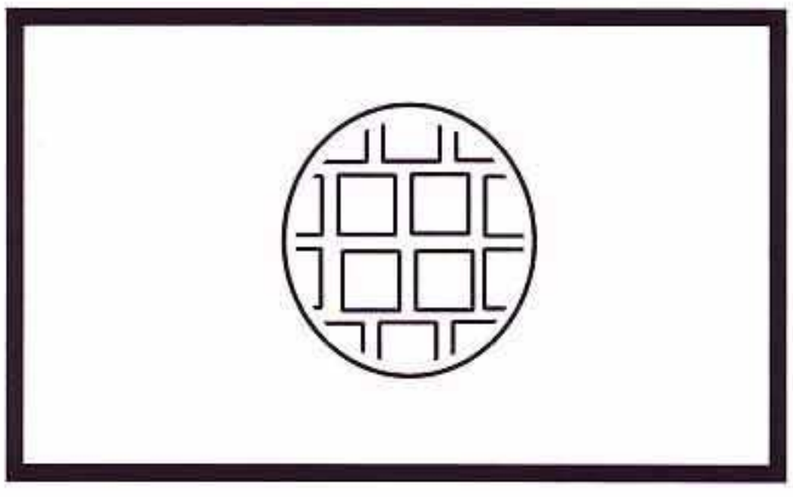
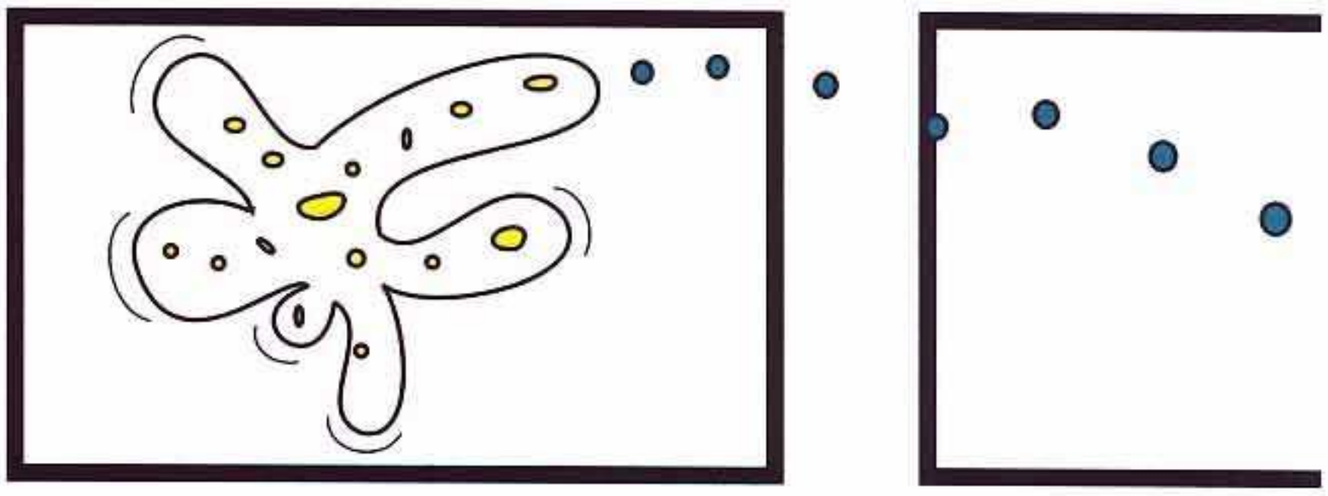
CHAPTER TEN

CANCER



Benign tumours grow slowly and have a regular shape and capsule. But they can become large and so compress things like blood vessels.

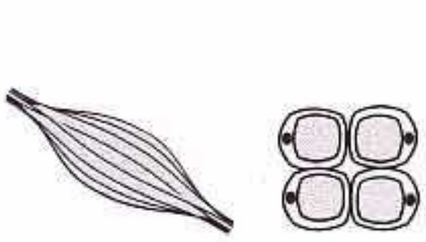


Malignant tumours grow rapidly. They have irregular structures, invade adjoining tissues and often release metastases.

Easy reading

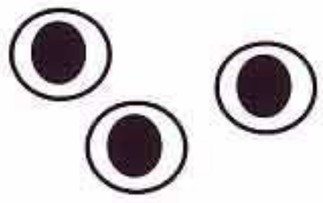
Technical information

WHERE SOME COMMON TYPES OF CANCERS ORIGINATE FROM



Sarcomas...

develop from fat and muscle cells.

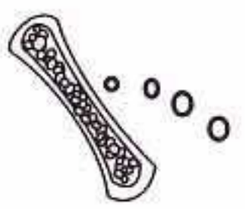


Lymphomas...

Cancerous lymphocytes.

Carcinomas...

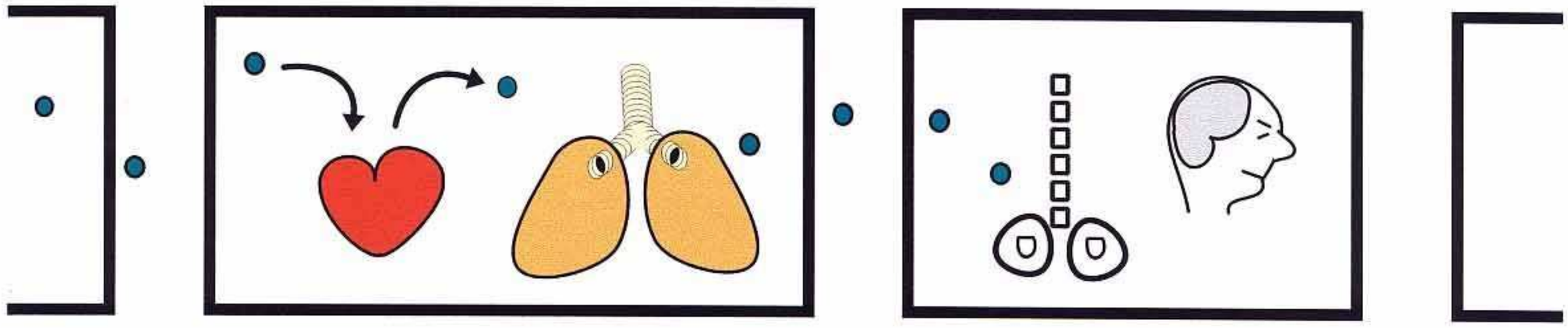
originate from epithelial cells.



Leukaemia..

Malignant blood cells.

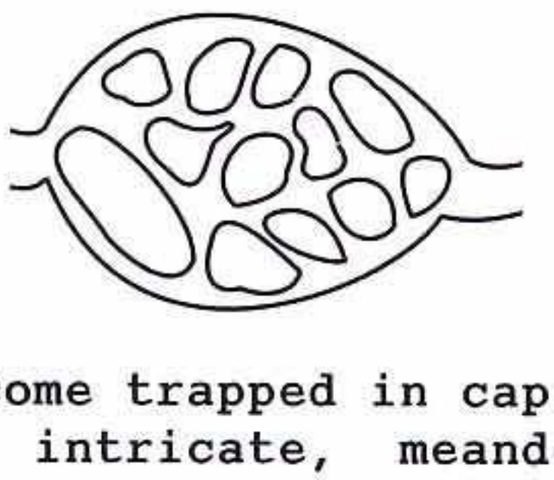
SECONDARIES



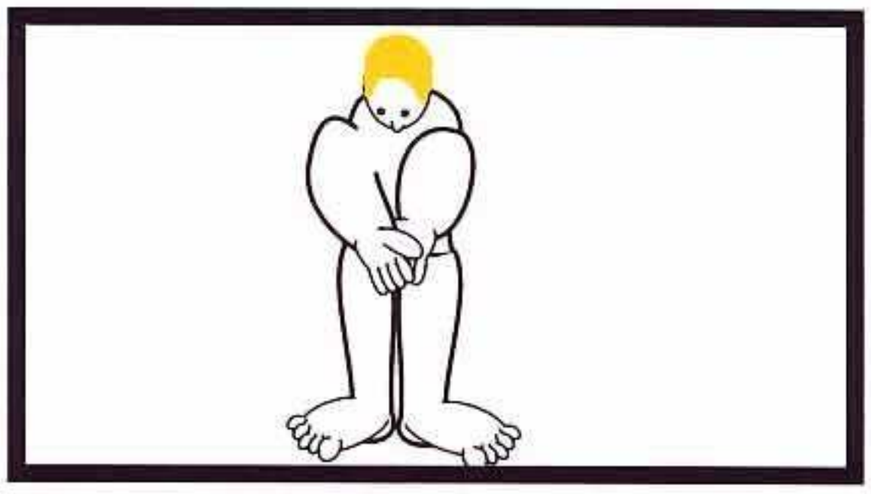
Metastases released into the blood or lymph, are carried to the heart and then in to the lungs, where they may become trapped.

Or they travel onto other parts of the body, like the brain or bones and develop there.

Metastases do not get trapped in the heart, because there are no intricate channels, only 4 large chambers.



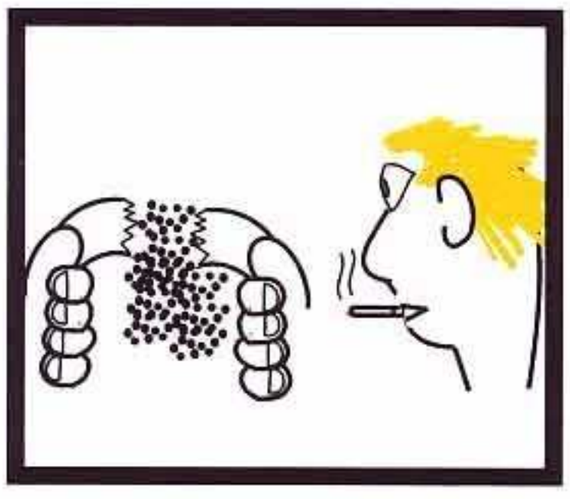
Metastases become trapped in capillary networks due to their intricate, meandering channels.



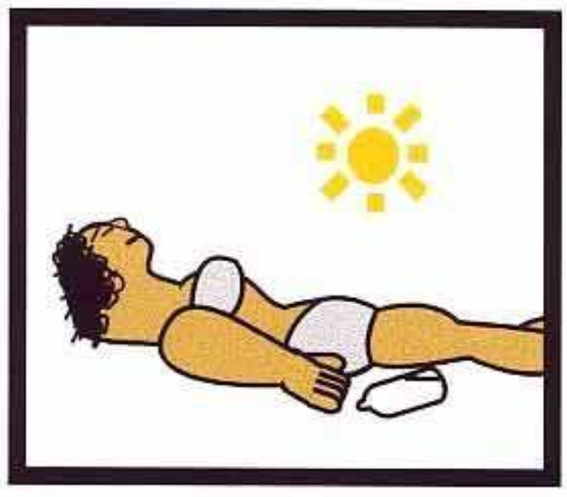
However, with cancer of the prostate, metastases from this tumour frequently become lodged in the patient's bones.

It appears that when some tumours turn malignant, the metastases find it easier to attach and then develop into a secondary, at specific sites in the body.

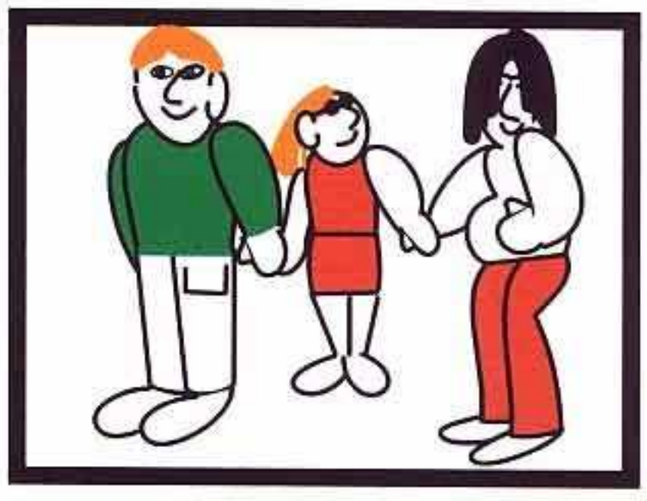
SOME LIKELY CAUSES OF CANCER



Chemicals such as soot, tobacco tar and asbestos.

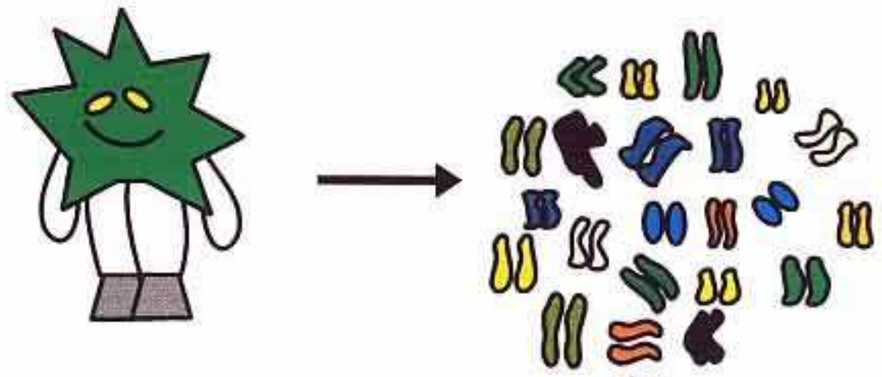


Physical damage due to X rays, UV light etc.



Inherited genetic defects may be the reason many cancers appear to 'run' in families.

Eating too little fresh fruit, vegetables and roughage, appears to increase the chances of acquiring certain cancer.

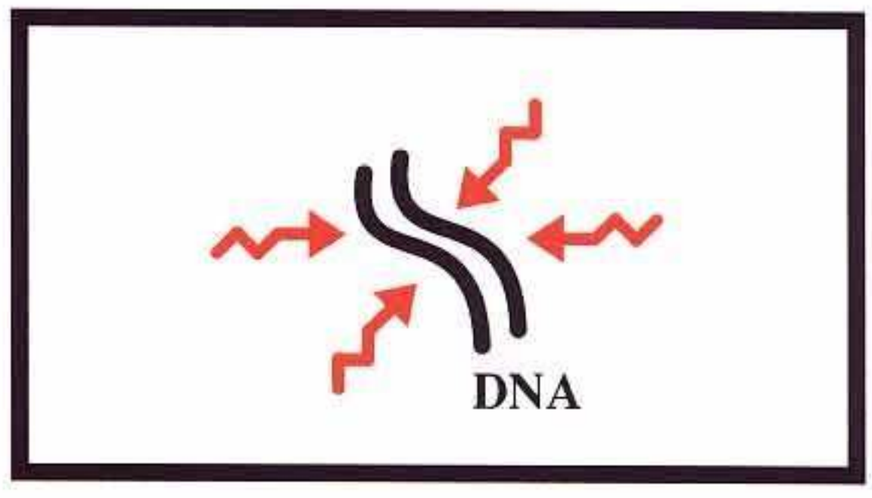


Viral genes acquired following an infection, could turn a cell malignant, by affecting the processes involved in random gene rearrangemnt (see page 121).

LOOKING FOR SECONDARIES

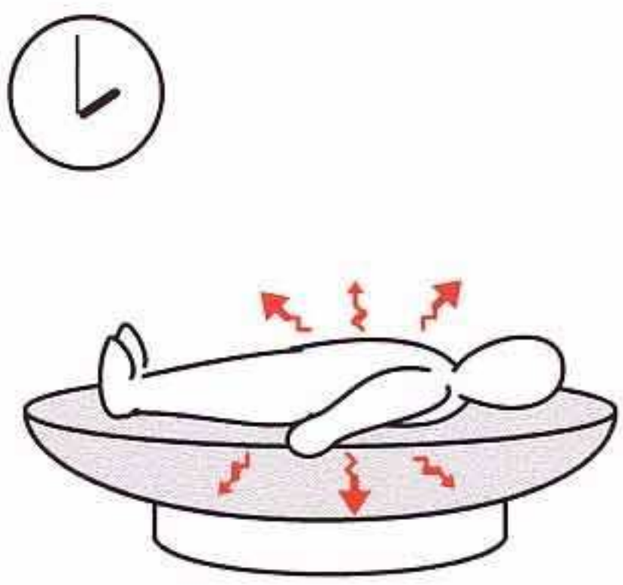
Almost overnight, Paul finds that he can't walk and has to go to hospital to find out what's wrong.

Here he drinks a solution containing chemicals, which will be absorbed by any replicating cell.

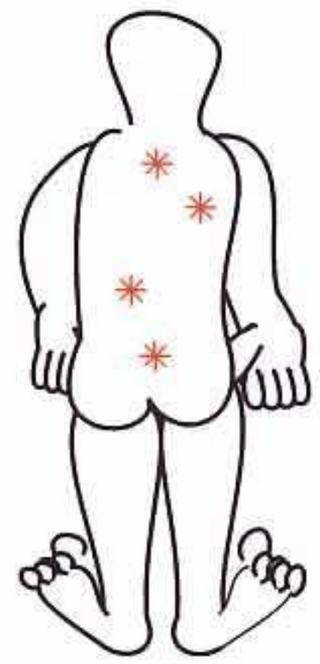


As cancer cells replicate faster than normal cells, they will absorb more of these chemicals, which were labelled with a small amount of radioactivity.

A FEW HOURS LATER

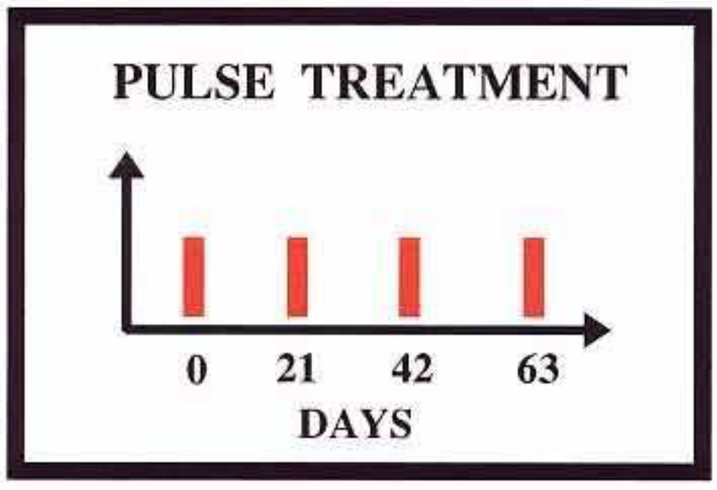


Paul lies on a receiver, which will pick up traces of radio-activity emitting from him.

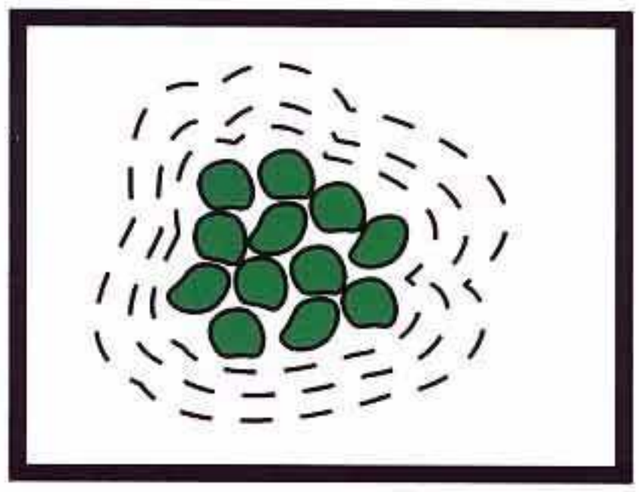


Any tumour will now appear as a 'hot spot', having absorbed more of the labelled material.

ANTI - CANCER DRUGS (ie CHEMOTHERAPY)



Because anti-cancer drugs affect all replicating cells, treatments are spaced out to allow normal cells time to recover.



Tumour cells are generally less resillient and hopefully have insuffient time to recover and die.

Often the most distressing side effects for the patient are the loss of hair, vomiting and diarrhoea.

The worst side effects of chemotherapy are on parts of the body made up of cells that replicate quickly.

The lining of the gut

↓

Vomiting
Diarrhoea

Hair folicles

↓

Baldness

A foetus

↓

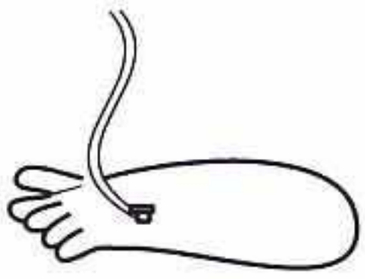
Potentially fatal

Sperm

↓

Possible infertility

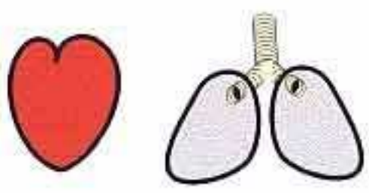
OTHER SIDE EFFECTS OF CHEMOTHERAPY



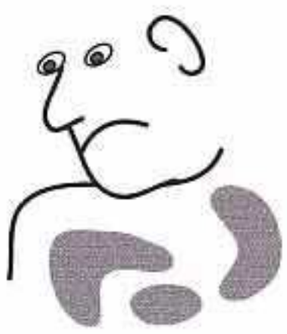
Anti-cancer drugs are very toxic and can cause a lot of damage if they happen to leak into the tissues at the site of the infusion.

Cytotoxic drugs can cause uric acid deposits to build up in the urinary tract, so lots of water must be consumed to flush away these impurities.

Because many anti-cancer drugs are toxic to nerves, peripheral neuritis is sometimes experienced in the hands and feet.



Heart and lung irritation are sometimes experienced.



Skin pigmentation may appear, following the use of steroids.

HOW SOME CYTOTOXIC DRUGS WORK

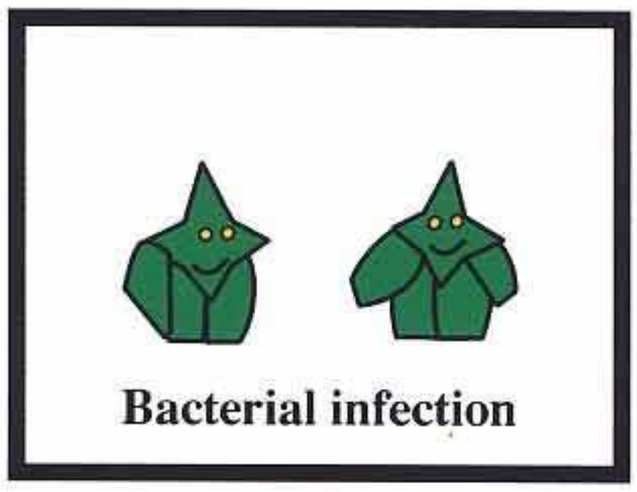
Alkylates (ie Cyclophosphamide), damage DNA so that cell division is prevented.

Vinca alkaloids (ie Vincristine), disrupt microtubules during chromosomal replication.

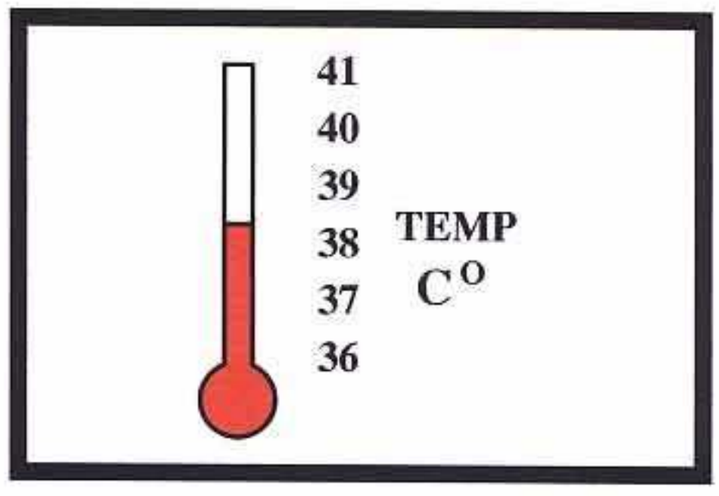
Antimetabolites (ie Methotrexate), attach to enzymes and so prevent normal cell division.

INFECTIONS IN THE IMMUNOSUPPRESSED PATIENT

As cytotoxic drugs affect all replicating cells in the body, the immune system is frequently affected.

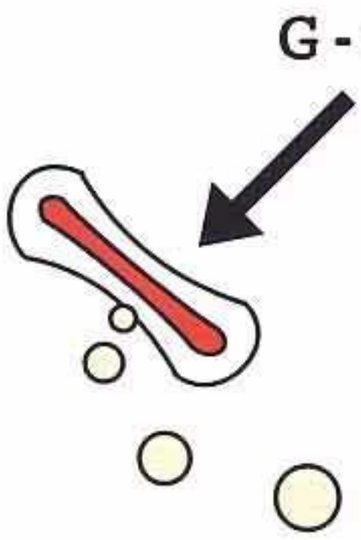


The bone marrow is often unable to release sufficient numbers of neutrophils to combat an infection.



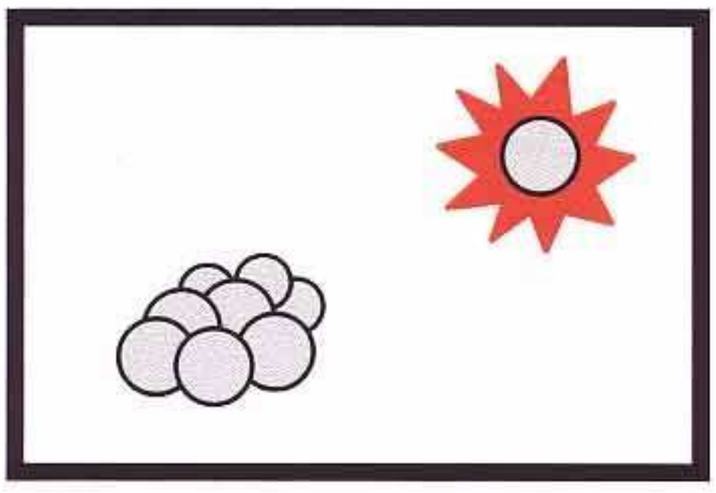
Hence, patients undergoing anti-cancer treatment require daily temperature readings to detect early signs of an infection.

These patients often have a reduced number of neutrophils (ie they are neutrophenic). So at the first signs of an infection (such as a raised temperature), antibiotic treatment is commenced.

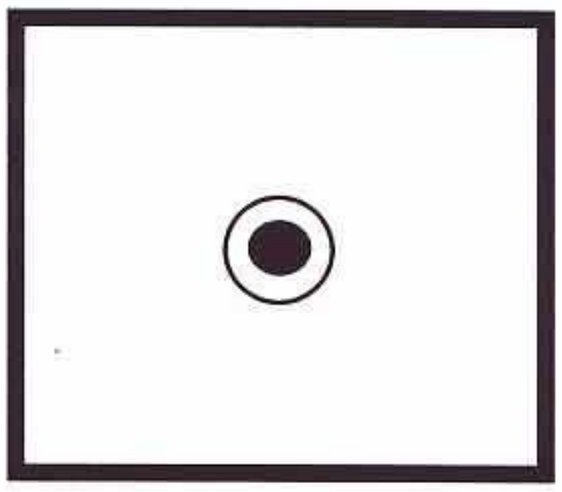


Severely immuno-depressed patients are at risk from overwhelming infections. So they may be given bone marrow stimulants, such as granulocyte colony-stimulating factor or G-CSF (see page 90).

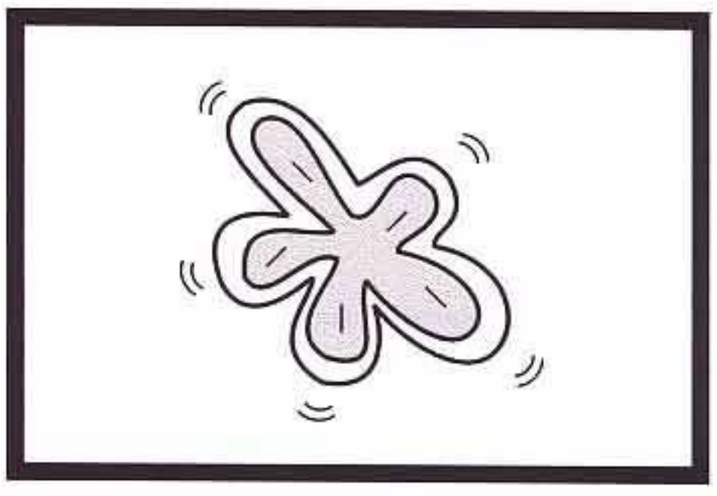
THE WILL TO LIVE



A normal cell needs positive signals from adjoining cells, as it will die if kept in isolation.

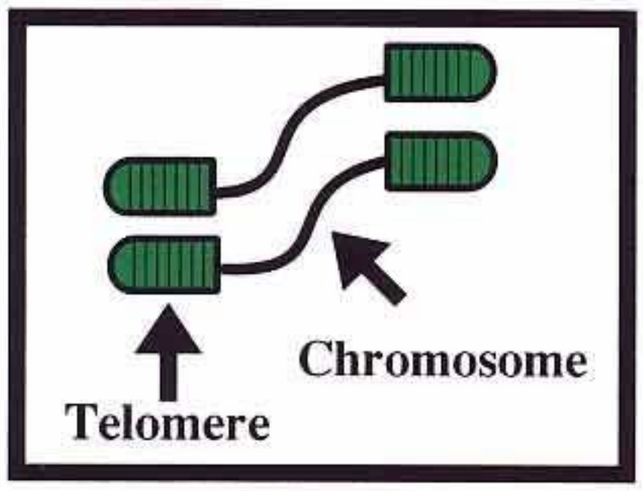


But isolated cancer cells can survive indefinitely and become 'immortal'.



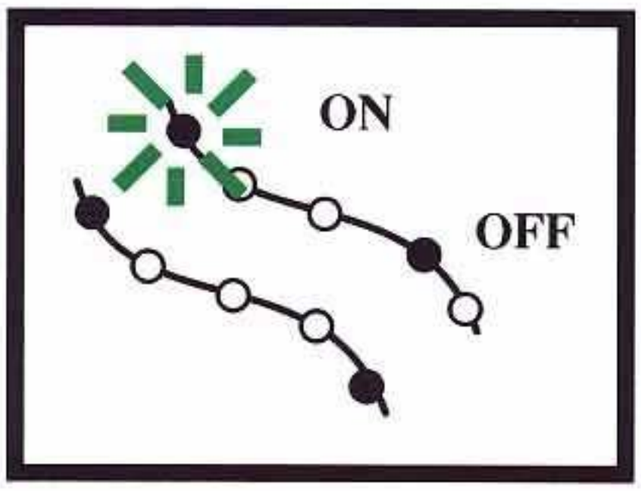
Malignant cells can also 'ignore' negative growth signals as they invade adjoining tissues.

CELLS OUT OF CONTROL

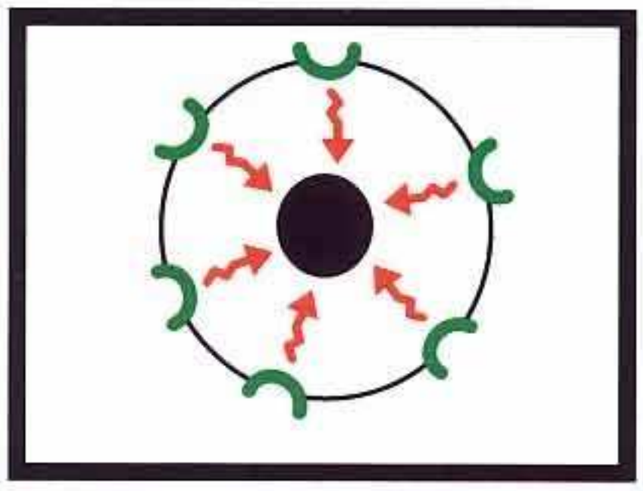


Chromosomes have end pieces called "telomeres". These shorten each time a chromosome is copied. As a telomere can only shorten to a certain point, a normal cell is unable to replicate indefinitely.

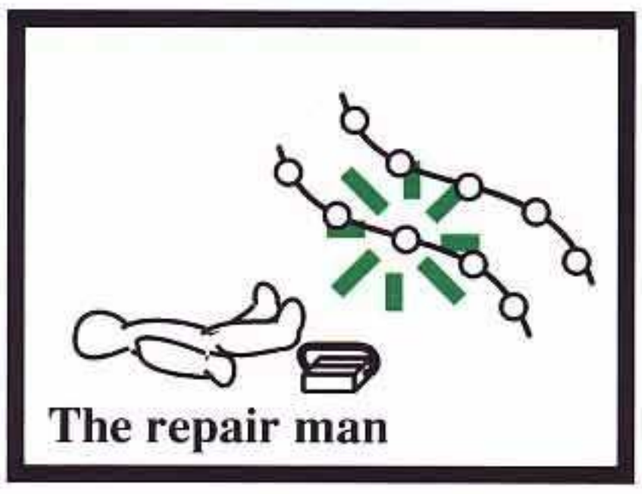
All tumour cells acquire enzymes which add material to telomeres. This stops the telomeres shortening when the chromosomes are copied, so that the cell can now replicate indefinitely.



Along any chromosome, there are many ON and OFF genes. In cancer cells, an ON gene (oncogene) could become jammed on, or an OFF gene (tumour suppressor gene) may have failed to work.



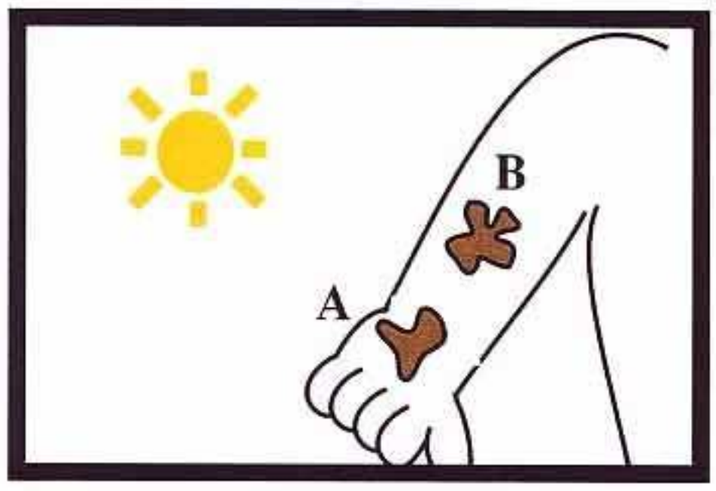
Growth receptors on the surface of a cell could malfunction and start to fire impulses to the nucleus, without any growth factors being attached.



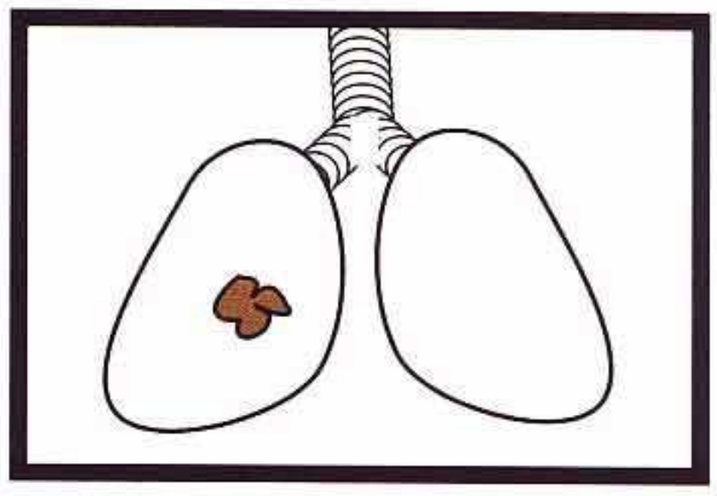
Some cells appear to lose the ability to repair damage sustained to a chromosome and the unrepaired genes could now turn the cell cancerous.

The repair man

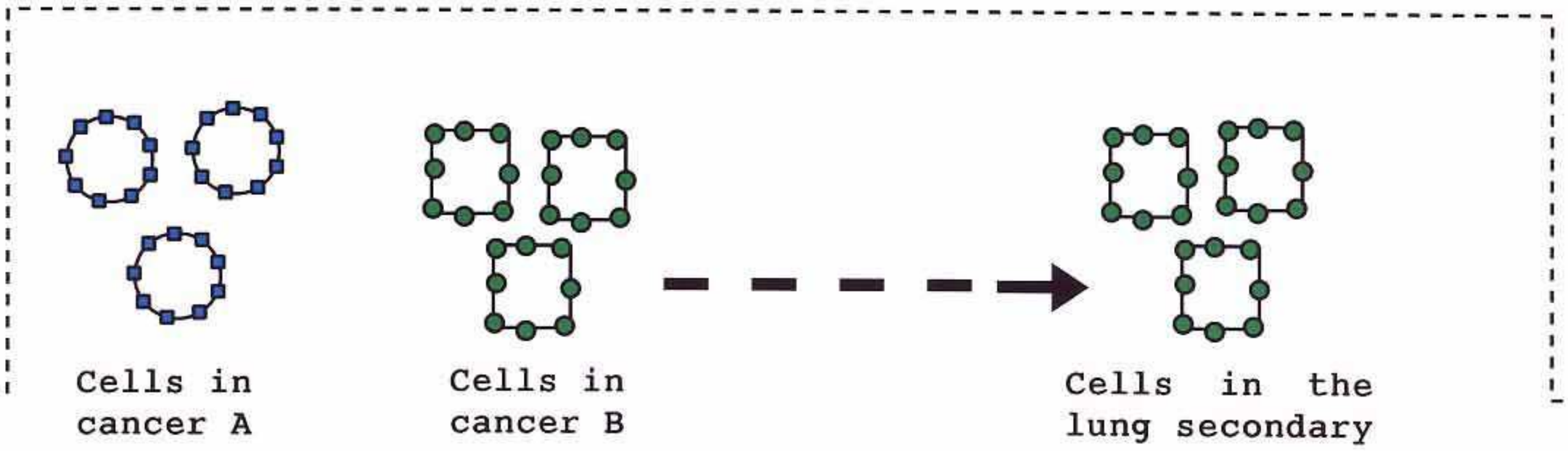
RANDOM GENE MUTATION



These skin cancers were caused by the sun, randomly damaging genes inside 2 skin cells.



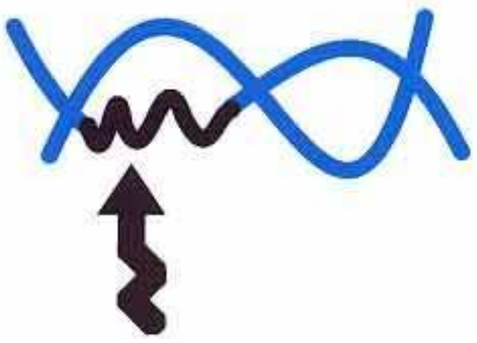
Some time later, a secondary, originating from tumour B, has developed in the lungs.



Random gene mutation means that cells in the 2 skin cancers are very different.

But cells in the secondary will be identical to those found in the primary.

DANGEROUS GENES?



Sunlight, X rays and chemicals can all damage our DNA (genes) and this might then turn a cell cancerous.

Inherited genetic defects could cause a cell to malfunction.

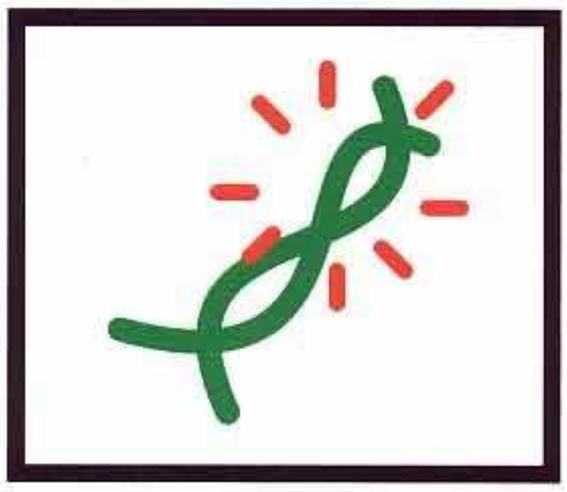
Viral genes incorporated onto a human chromosome, may deregulate the normal genes and trigger uncontrolled cell division.

Something might cause a malfunction to the enzymes in the nucleus and this initiates uncontroled cell division.

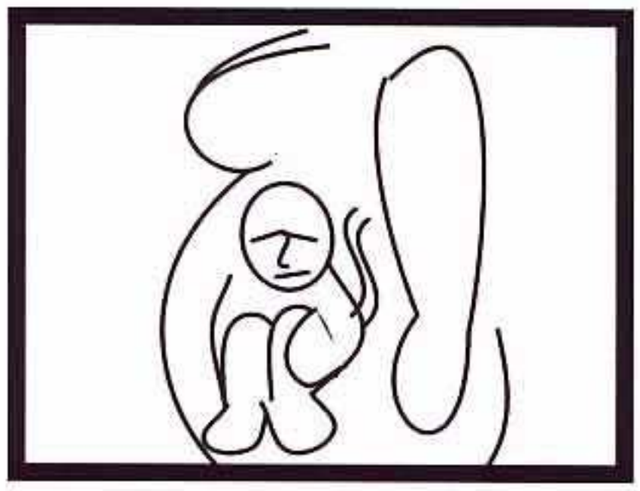
SILENT GENES

It is possible that an external factor, could accidentally activate a gene which is not normally used and this then triggers unrestricted cell division.

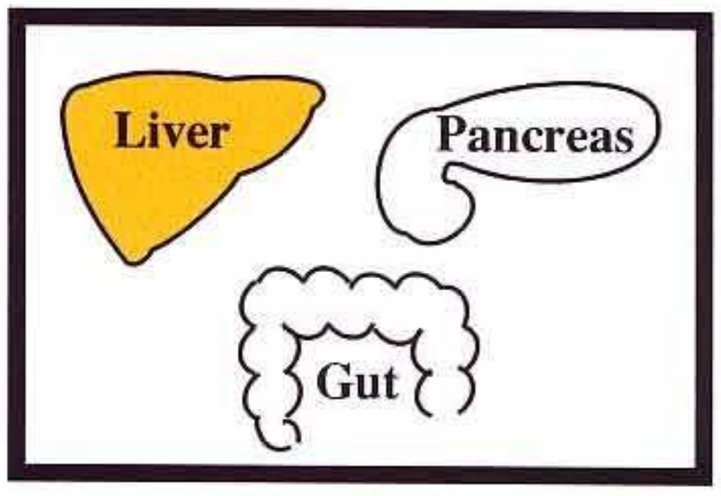
ONCOFOETAL GENES



Certain genes inside a pregnant mother and her foetus, start to work.

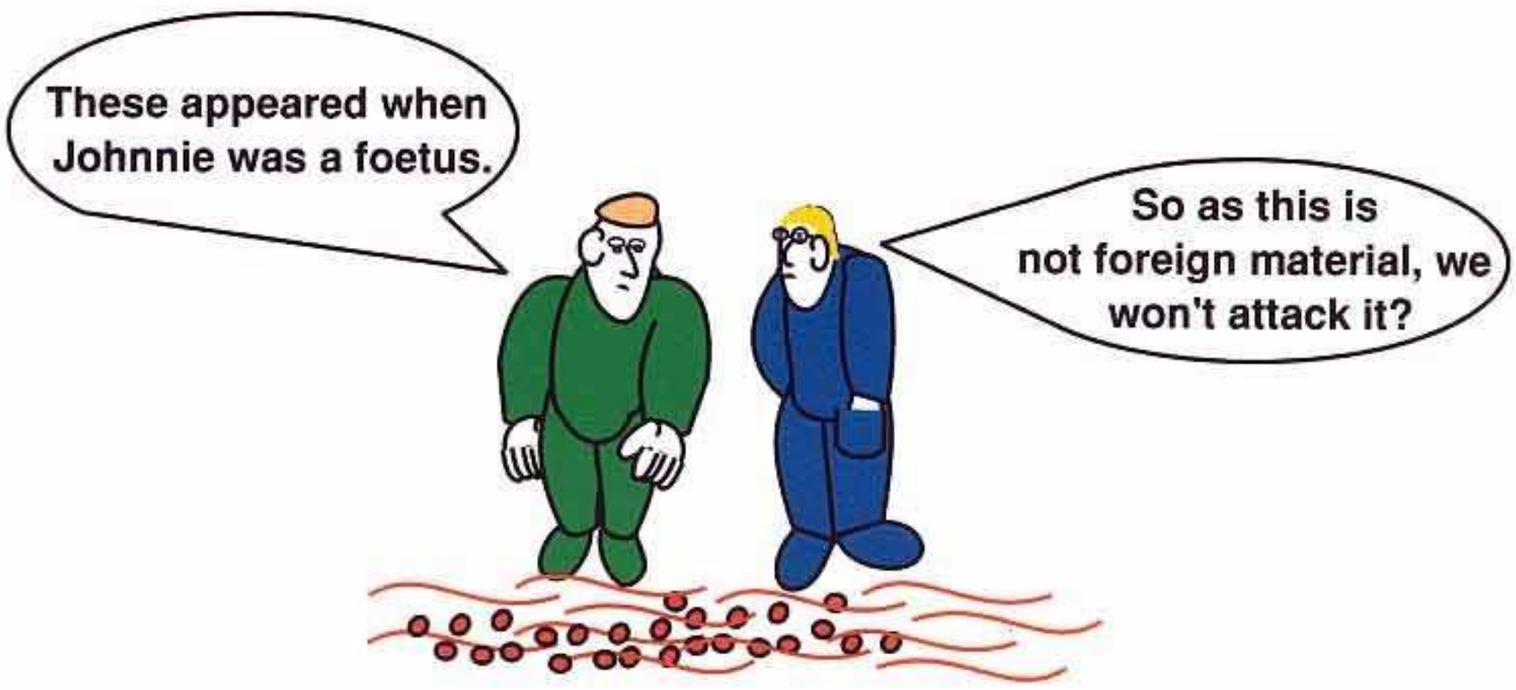


Alpha - fetoprotein (AFP) soon appears in both the foetal and maternal blood.



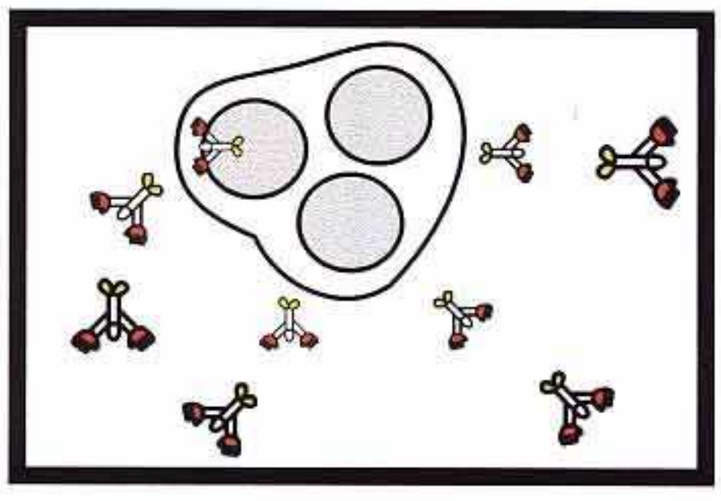
Carcinoembryonic antigen (CEA) coats the surface of certain foetal organs like the gut and pancreas.

After the birth, the oncofoetal genes are switched off, so that both AFP and CEA soon disappear from inside the mother and her newborn baby.

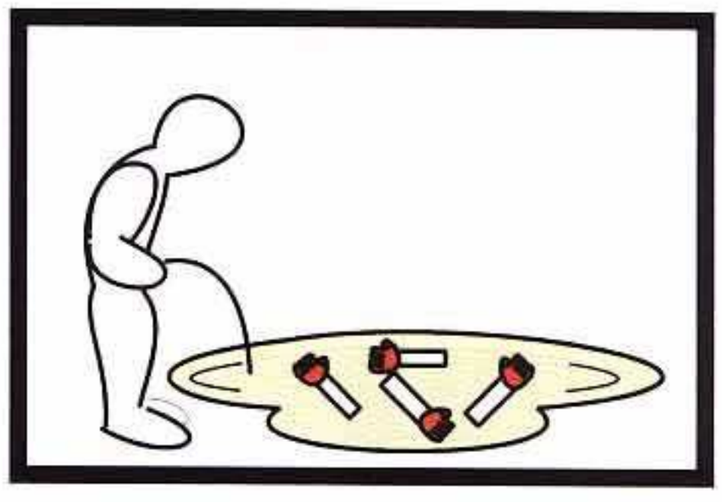


But both sets of genes can be turned back on. AFP is released by some liver and testicular cancers. CEA reappears in people with certain bowel cancers, emphysema and those who smoke or drink heavily.

BENCE - JONES PROTEINS



Myelomas which develop from malignant plasma cells, release many identical antibodies.

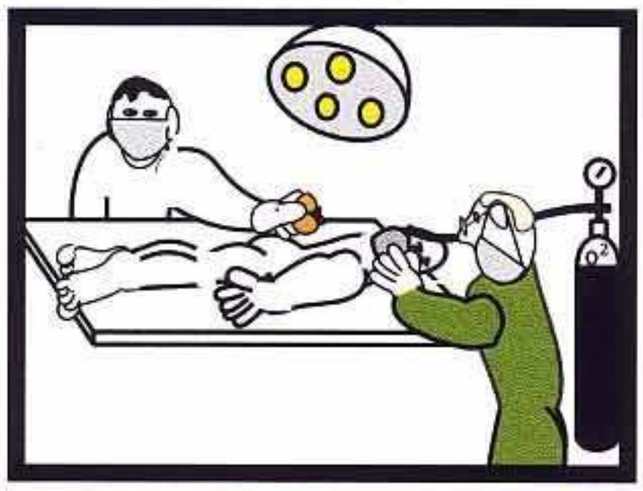


Often, antibody light chains (ie their 'arms') now start to appear in the patient's urine.

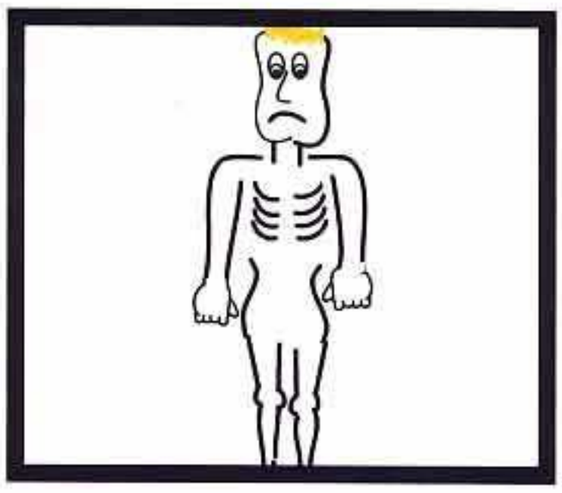
When light chains appear in the urine, they are called "Bence-Jones proteins".

DO VIRUSES CAUSE CANCER?

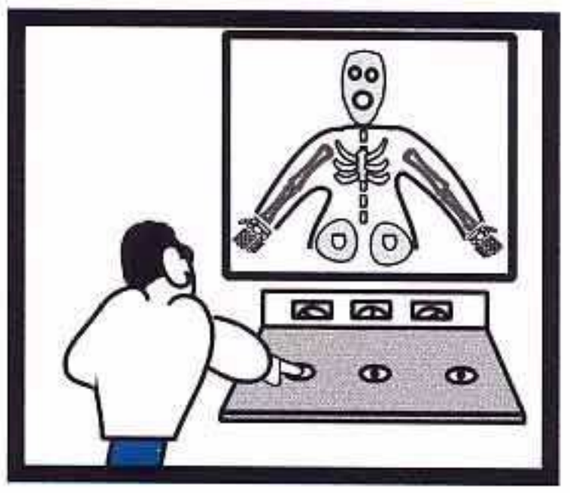
Before answering this, remember that T cells are responsible for eliminating virally infected cells.



To stop a transplant from being rejected, a patient's T cells must be suppressed.



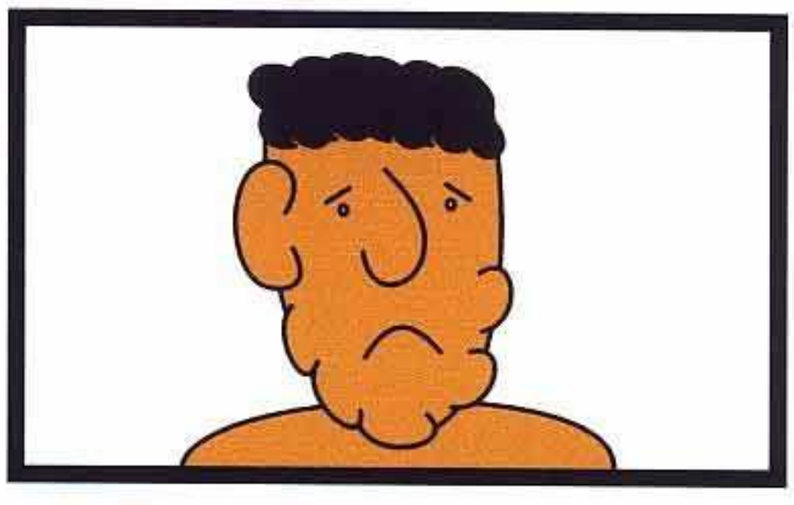
People with AIDS have few, if any, T helper cells.



Radiotherapy can badly deplete T cell numbers.

Although there is NO increased incidence of the commonest cancers in these patients (ie lung, breast and gut tumours), there is a 50 times increase in the incidence of lymphomas.

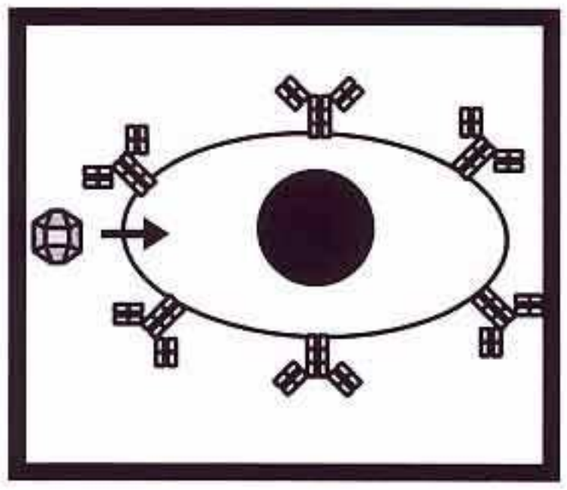
In parts of West Africa, a certain strain of malaria is endemic.



And here there is a high incidence of young people suffering from Burkitt's lymphoma.

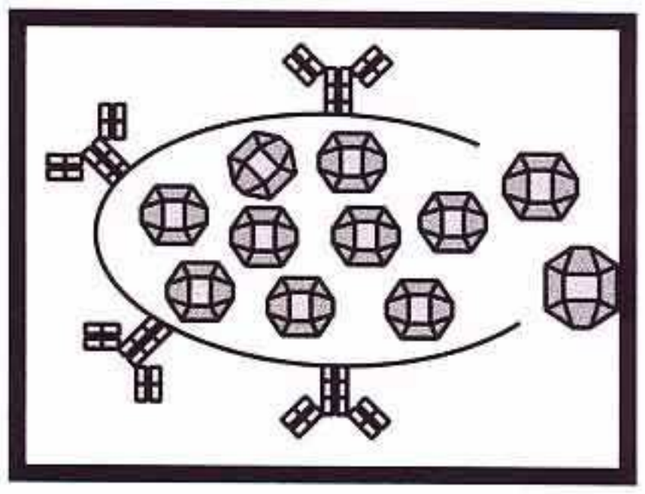
This strain of malarial, appears to deplete T cell numbers. This could then account for the high incidence of Burkitt's lymphomas in West Afican young people.

LYMPHOMAS AND THE IMMUNOSUPRESSED PATIENT



The Epstein-Barr virus routinely infects most B lymphocytes.

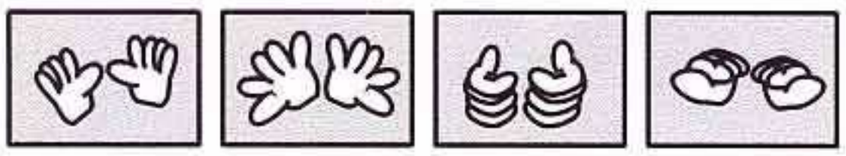
But if the virus then starts to replicate itself, the infected cell is eradicated.



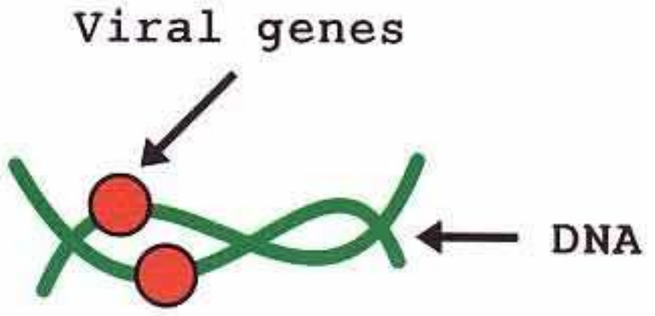
So if the T cells were to be removed, the virus could now replicate unhindered.

Although a lack of T cells would allow a virus to replicate unhindered, how could this now cause the infected B cell to become cancerous?

WHAT MAKES LYMPHOCYTES DIFFERENT TO OTHER CELLS?

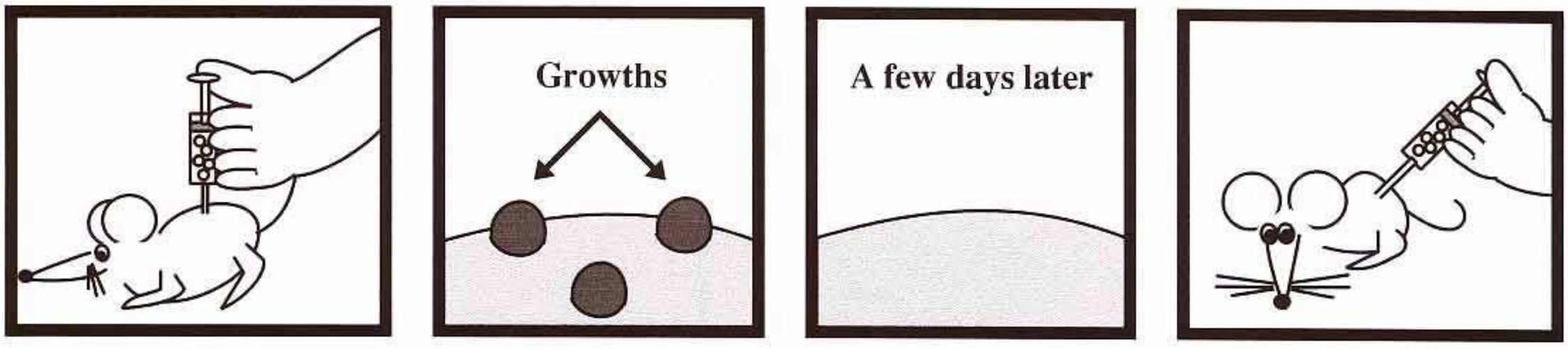


Each mature lymphocyte has a unique 'hand' shape, due to recombinase enzymes.



If the virus can now replicate unhindered, this could affect these enzymes, turning the cell cancerous.

IS THERE AN ANTI - TUMOUR MEMORY?



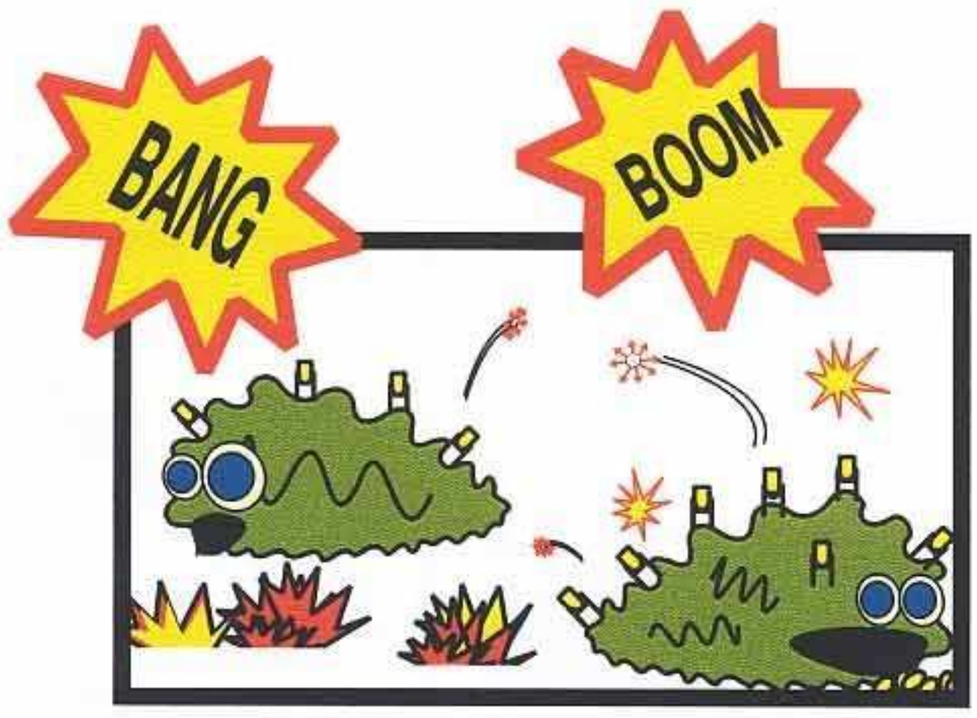
Cancer cells from a genetically identical mouse are injected.

Skin growths appear for a few days and then vanish.

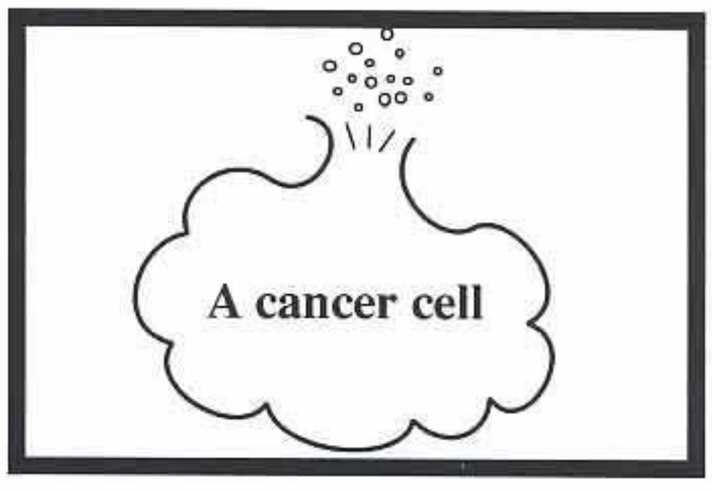
But when more of these cancer cells are injected, no new growths appear.

This indicates that the immune system could have an anti - tumour memory.

TUMOUR NECROSIS FACTOR (TNF)



Whenever macrophages are activated, they release a cocktail of chemicals including tumour necrosis factor.

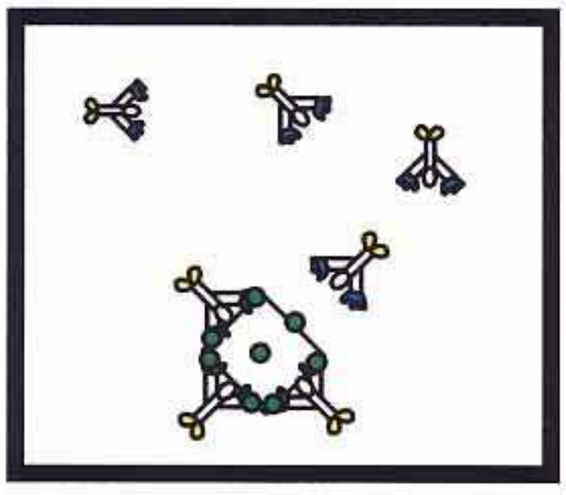


Tumour necrosis factor has a range of actions, one of which causes some cancer cells to die.

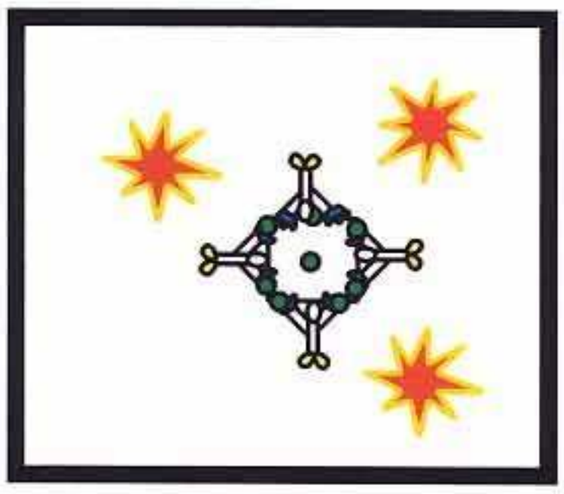
Most cells have receptors for TNF. If TNF binds to these, toxic chemicals are produced inside the cell.

Normal cells deactivate these, whereas some cancer cells seem to lose this ability and die.

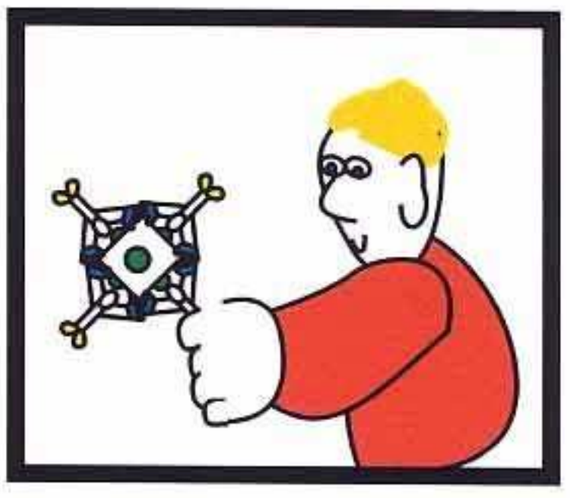
HOW ANTIBODIES MAY HELP FIGHT CANCER?



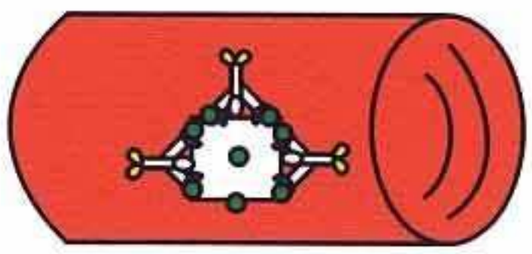
First, antibodies must attach onto the cancer.



Complement activation could now follow.

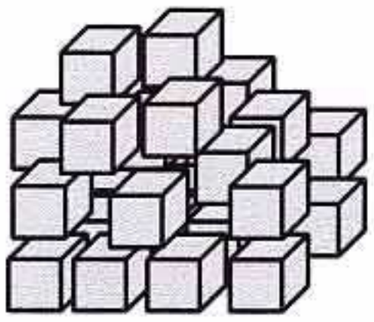


Or, the cell is eliminated by an immune cell.

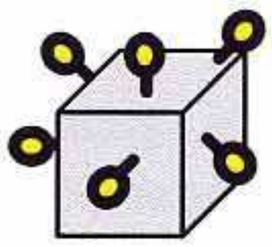


If antibodies manage to coat the surface of a metastase in the blood, the cancerous cell may be prevented from attaching onto the side of a capillary and developing into a secondary (see page 196).

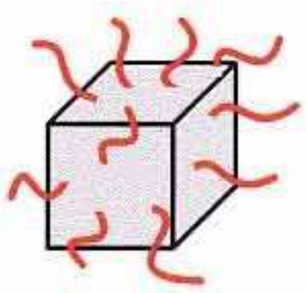
HOW TUMOURS MAY EVADE IMMUNE ELIMINATION



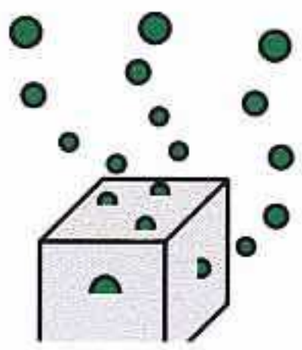
The rapid growth associated with many cancers could overwhelm the immune system.



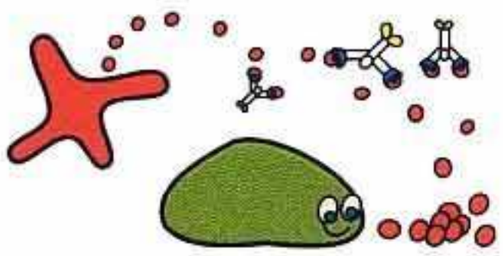
Some tumours express more glycocalyx molecules than normal cells and this could 'hide' the cancer from the immune system.



Other tumours coat themselves in fibrin, which could 'mask' them from the host's immune system.



Many tumours release transforming growth factor. Because this affects macrophages and lymphocytes, their anti-cancer capabilities may be affected.



A tumour could protect itself by releasing 'blocking factors', which occupy the immune system and so allow it to remain untouched.