- **Four in every ten of us will develop cancer. However ...**
- **Your diet can greatly increase or reduce your risk of cancer**
- **Anti-oxidant supplements alone are not enough to protect against cancer – food offers at least eight distinct anti-cancer families of nutrients**
- **Eating the right foods leaves your cells swimming in a sea of anti-cancer compounds, backed by a strong immune system**
- **Upping the amount of fruit and veg you eat can cut your cancer risk in half**
- **Four servings of tomato a week may cut prostate cancer by a fifth; eating cabbage, tomatoes and resistant starches (pre-biotics) regularly should reduce the risk of bowel cancer by over two thirds**
- **Soy beans, shark cartilage and bilberries contain substances that can slow or stop cancer spreading**
- **Poly-unsaturated fatty acids in grains, nuts and fish oils have been shown to destroy cancer cells, and may obliterate many before they become tumours**
- **The anti-cancer diet is almost identical to the anti-heart disease and anti-diabetes diet**

Chapter 13

Fighting cancer with food

As a potential cancer victim (along with everyone else), I'm almost as afraid of the treatment I'd receive as I am of the disease itself.

Chemotherapy, radiotherapy and surgery are not kind to patients, even though cure rates for certain cancers are creeping up. We're still waiting for that elusive breakthrough – like the antibiotics that turned the tables against bacterial diseases.

The health philosophy that prevention is better than cure holds true for all disease – but none more so than cancer.

Causes and effects

The four main causes of cancer are radiation, toxins, infections and food.

Radiation includes solar, nuclear and geological, such as the radioactive gas radon released by granite.

Toxins include tobacco, lead, diesel exhausts, dioxins and asbestos.

Infection includes certain viruses (linked to cervical cancer, liver cancer and leukaemias); bacteria (associated with stomach, colon and other cancers); and fungi, a significant cause of cancer in tropical and sub-tropical regions[1].

Smoking causes 35 per cent of all cancers[245]; another 30 per cent are related to dietary factors[2-4]. Certain foods contain carcinogens; but on the other hand foods also contain a rich mix of anti-cancer compounds. The anti-oxidants have received an enormous amount of publicity, but they are only one element in the protective mix.

It's fine to take anti-oxidants, and there's plenty of evidence that this will improve your long-term health – but there's more to it than that. This chapter spells out just what else you can do to reduce your risk of cancer or, if you already have cancer, how to improve your prospects with nutritional means alone.

THE CHINESE EVIDENCE

One of the best-known trials which showed the protective effects of anti-oxidants was the massive Linxian trial, held in China. Thirty thousand men and women were given Vitamin A and zinc; or riboflavin and niacin; or Vitamin C and molybdenum; or Vitamin E, beta carotene and selenium.

These are sub-optimal combinations of nutrients, and the doses used were relatively small, but there was a 13 per cent decline in total cancer deaths[15]. The problem with the Linxian trial, as far as we are concerned, is that it may not be relevant in the developed countries. Linxian is an area with very poor nutrition and a very high cancer rate, especially of the stomach and oesophagus; would anti-oxidants be as effective in populations who are better nourished?

Various smaller trials suggest that anti-oxidant supplements benefit us too. For example, a high Vitamin C intake has been shown to reduce the risk of cancers of the digestive tract[143], probably by inhibiting nitrosamine formation.

In another trial, supplements of Vitamin E reduced the risk of oral cancer[16]. Conversely a low intake of carotenoids, Vitamin E and other anti-oxidants is associated with high cancer risk[140].

Anti-cancer clues

Some recent techniques – one such is cancer 'immunisation' – are very promising and will undoubtedly help to make cancer therapy more effective, and less painful. But they are high tech, and not available just yet. They will be expensive, requiring medical professionals and services.

Factors in the diet which can cause cancer include

- **aflatoxins (eg in stale peanuts) and nitrosamines (eg in hot dogs)**
- **probably sulphate and sulphite preservatives**
- **charred meats**

Dietary factors which help protect against cancer include

- **anti-oxidants, enzyme inducers, immuno-supportive nutrients**

Food factors which can help suppress a cancer include

- **re-differentiators such as genistein, butyric acid, lycopene and alpha carotene**
- **angiostats such as genistein and various flavonoids**
- **apoptosis (cell 'suicide') inducers such as genistein, various flavonoids, and carotenoids such as lycopene and alpha carotene**

In the meantime, there are a series of safe, inexpensive, nutritional steps you can take which will reduce your own risk of cancer dramatically.

A predominantly vegetarian diet helps, but this is just the beginning. If we knew which fruits and vegetables had the strongest anti-cancer effects, we could select our diet accordingly, and cut the cancer risk still further.

Food and cancer

Experts believe that as many as 30 to 40 per cent of all cancers in the West are diet-related[5, 6].

Many important cancers (including cancer of the prostate, breast, stomach, liver, colon, oral cavity, oesophagus and ovaries) are significantly reduced by a fruit and vegetable diet, and are up to 20 times less common in some countries than in others[14].

If we knew just what it was in the fruit and vegetables which protected us against cancer, we could try to breed new strains of those crops which contained higher levels of the crucial ingredients. Alternatively, we could take concentrated extracts of fruits and vegetables in pills and capsules, to gain a similar advantage.

Stop Press!

The UK Government-funded John Innes Research Centre has bred a strain of super-broccoli.

It contains 100 times the normal level of sulphurophene, a sulphur compound with strong anti-cancer properties – particularly colon cancer, which kills 25,000 people a year in the UK.

The pharmaceutical industry isn't very interested in marketing such things, as they can't be patented; but they are busy making their own versions of some of the key compounds, and these will start to enter the market in the next few years.

And that gives the game away. Many important anti-cancer compounds in plants have been identified. What's more, they have been grouped into several distinct categories, on the basis of the type of risk reducing effect each one offers.

Different scientists have proposed different sorts of categories, so the one which follows is a compromise, but it will give you a reasonably comprehensive guide as to what food has to offer.

Eight vital elements in the fight against cancer

Cancer avoidance

1 First there are the **classical anti-oxidants**, which neutralise the dangerous free radicals produced inside the body by radiation and by some toxins.

These include:

- Vitamins A, C, E, D, K and some of the B group
- Co-enzyme Q10
- alpha-lipoic acid
- the plant compounds called the flavonoids
- the carotenoids, such as lycopene
- melatonin.

2 The second group of cancer-protective substances in food are the **enzyme inducers**. These are compounds which stimulate the body into producing higher than normal amounts of 'detoxifying' enzymes.

Some of these enzymes can neutralise free radicals. Another group (Phase 2 enzymes) speed the removal of carcinogens from the body.

In this category are compounds like quercitin and sulphurophane – found in onions, cabbage and broccoli.

3 A group of compounds which have the ability to wrap themselves round the fragile DNA inside our cells, providing a **shield** against harmful influences. Most of these appear to be flavonoids.

4 A group which **binds directly to potential carcinogens** and speeds their excretion from the body. Chlorogenic acid, a flavonoid found in tomatoes, is one example.

5 **Immuno-enhancers** are substances which improve the immune system's ability to mount a defence against foreign organisms such as cancer cells.

- Various herbs like echinacea have been shown to increase the number of natural killer cells (which can kill cancer cells). They also boost production of interferon, a natural anti-cancer 'hormone'.
- Some ingredients in plant fibre, such as the pectic polysaccharides, have a similar effect; as do related polysaccharides found in certain mushrooms, fungi, the cell walls of some bacteria and the gritty particles in pear skin.

50% potential risk reduction

By increasing your intake of fruits and vegetables, evidence is accumulating that you can potentially cut your risk of cancer almost in half, and the risk of certain cancers by 75 per cent[3, 12, 13, 120, 181, 211].

People who eat fruits and vegetables rich in anti-oxidants have less genetic damage[81] – one of the precursors to cancer.

Cut skin cancer by 70%

One recent study indicated that taking Vitamin A could reduce the chance of basal cell carcinoma – the most common form of skin cancer – by 70 per cent[133].

- Some bacteria which live in the gut have been reported to improve immune performance: these are the lactobacilli and bifidobacteria, the organisms in live yoghurt. These can be increased in the gut by eating non-digestible oligosaccharides found in foods like oats, onions and Jerusalem artichokes (see Chapter 7, Pre-biotic fibre).
- Co-enzyme Q10 is not strictly speaking an immuno-enhancer, but should be used in conjunction with all the above agents, as it increases the energy with which the immune system can go to work. Interestingly, there are reports that indicate that high doses of Q10 alone (around 400mg/day) can induce remission in some cases of breast cancer[182-184] (see Chapter 9, Co-enzyme Q10).
- Glutamine – this amino acid prevents the immuno-suppression caused by excessive physical exercise.
- Adaptogens – such as Siberian ginseng – can prevent the immuno-suppression caused by excessive stress.

Could we eliminate most cancers?

By identifying the anti-cancer elements in the diets of the low risk countries, we too may be able to achieve the same low risk status.

This chapter will look at those elements.

Cancer containment

6 **Anti-cancer nutrients** improve connections between cells, and help to bring cancer cells back under normal control. The carotenoids are important members of this group, and are found in orange and red plant foods such as peppers, carrots and tomatoes, and in dark green leaf vegetables. Genistein, an isoflavone from soy, is another, as is selenium.

7 **Anti-growth factors**. These work in different ways, but all have the ability to inhibit the growth of tumours, to slow the growth of new blood vessels to supply those tumours, and to impede the tumour's ability to spread (metastasis).

Into this category fall:

- protease inhibitors, such as lectins (found in beans like soy beans).

- matrix stabilisers such as flavonoids (in grapeseed, the bark of maritime pine, quince, etc), flavolignans (flaxseed) and flavonoid-like compounds found in herbs such as echinacea; and the closely related …
- angiostats, such as genistein (in soy), or the glycoproteins found in shark cartilage (see page 197, and Chapter 6, Flavonoids & isoflavones).

8 **Redifferentiators**. These compounds can force cancer cells back to normal or in some cases to commit suicide ('apoptosis'). They include butyrate, a fatty acid produced in the large bowel by (friendly) bifido-bacteria (see Chapter 7, Pre-biotic fibre), flavonoids including genistein and resveratrol, carotenoids including lycopene, and lectins including chokeberry and elderberry lectins.

THE ANTI-CANCER STORY SO FAR

Increase your intake of cruciferous vegetables like cabbage and broccoli, tomatoes, mushrooms, live yoghurt and soy-based foods. Your supplement regime should include a broad spectrum vitamin/mineral anti-oxidant supplement (at levels shown on page 348), a flavonoid complex (eg grapeseed, bilberry, etc.), Co-enzyme Q10, betaine and occasionally echinacea, plus a pre-biotic supplement.

When cancer begins

You can see that, although I placed anti-oxidants first in the list, they are merely one of a large number of categories of anti-cancer compounds.

This is why you cannot make up for a bad diet with anti-oxidant supplements alone. And when you consider that there are hundreds of carotenoids, thousands of flavonoids, and an unknown number of examples in most of the other categories, it all begins to seem rather confusing. But here's another way of looking at it, which should help to put it into some sort of perspective.

A summary of the anti-cancer shield

- **Anti-oxidants**
- **Enzyme boosters – especially found in cruciferous vegetables like cabbage, broccoli, kale and onions**
- **Flavonoids**
- **Carcinogen neutralisers, eg chlorogenic acid found in tomatoes**
- **Immuno-boosters – found in certain mushrooms, lactobacilli and increased when you eat oats, onions, inulin, soluble fibre and butyrate**
- **Redifferentiators such as carotenoids and genistein**
- **Compounds that inhibit the flow of blood to tumours, eg the soy derivative genistein, and other flavonoids**

The constant struggle

The potential for cancer is always present.

It is only because our cells are bathed in anti-cancer nutrients (mostly from plant sources) and our immune system is so efficient, that the inevitable DNA errors that accumulate don't always lead to cancer.

But when the diet causes immune impairment, or is deficient in anti-cancer compounds, it gives cancer the opportunity to overwhelm your defences.

The immune system depends on many vitamins and minerals to work properly. A good multi-vitamin and mineral supplement should provide the baseline support needed.

Additional supplements can then be used to give further protection.

Throughout our lives, cells in our bodies are dying, multiplying, and being replaced. Each time our cells divide, they have to copy the DNA they contain as accurately as possible; but they're only human. Mistakes creep in – mistakes that can lead to cell death or the uncontrolled growth of cancer.

To make matters worse, there is a constant background of low level radiation (unless you are a frequent flyer – one trans-Atlantic flight = four whole body x-rays!). Even at the best of times, our cells are constantly being irradiated. It's been calculated that the DNA in each cell receives around 1,000 hits per day, although a diet rich in anti-oxidants reduces the rate of DNA damage[204, 222].

The repair systems are very good indeed at spotting damage and repairing it, but they're not perfect and there is a steady accumulation of DNA errors with age. There is a constant risk of a cell somewhere in the body taking a wrong turn and becoming cancerous, a risk which increases with age as genetic errors accumulate and repair mechanisms slow down.

If our immune system is working properly it may spot the cancers early on, and kill them. But when the immune system is damaged (by immuno-suppressant drugs, malnutrition, stress or HIV), the incidence of cancers increases very significantly.

This is where our diet comes in. As you can see from the long list of protective food substances, our cells are swimming in a sea of anti-cancer compounds derived from the food we eat, and these act as a second safety net.

When you remember that almost all of these anti-cancer compounds come from the fruits and vegetables in our diet, it's easy to see why a vegetarian diet reduces the risk of cancer.

So what are the key anti-cancer compounds, where do you find them, and how should you put them together?

Anti-cancer strategy – Level 1 – Avoidance

The following are suspect, potential or actual carcinogens (cancer causing elements). Reduce your exposure whenever you can.

- Tobacco smoke
- Petrochemical compounds
- Preservative nitrates in bacon, hot dogs
- Smoked fish or meat
- Fats heated to high temperatures – 150ºC or over
- Saturated fat in excess amounts
- Pesticide and insecticide residues
- Charred meat
- Mould on nuts and grains
- X-rays
- Solar radiation

However, you don't get cancer by simply being exposed to carcinogens. You get cancer when the carcinogen load your body suffers overwhelms your body's natural repair ability.

That's why it makes sense to continually support your natural defence mechanisms with anti-oxidants, immuno-strengthening nutrients and other protective dietary factors.

Your anti-cancer strategy can be visualised in three levels:

Level 1 – Avoid it

Level 2 – Contain it

Level 3 – Kill it

Plants and protective enzymes

Fruits and vegetables contain anti-oxidant vitamins and other compounds, which shield us from free radicals which can otherwise cause cancer. But, although the anti-oxidant nutrients are important, they are the body's second line of defence against free radicals. The first line of defence is the anti-oxidant enzymes that our cells make themselves.

And we now know how to boost enzyme levels quickly and cheaply – by eating more fruit and vegetables.

Many fruits and vegetables contain substances which stimulate the body to speed up production of the major anti-oxidant enzymes. At the world-famous Institute of Food Research at Norwich, Dr Gary Williamson's team have carried out a survey of hundreds of different foods, looking for their ability to boost levels of the anti-oxidant enzyme quinone reductase.

Enzyme production needs minerals

The body will try to boost its own levels of anti-oxidant enzymes whenever levels of free radicals increase, whether this is caused by smoking, exercise or infection[153-154].

But these anti-oxidant enzymes need the trace elements selenium, zinc, manganese and copper to work properly.

As so many of us are depleted in these trace metals, we cannot always protect ourselves adequately.

Natural phase 2 enzyme boosters:

- **Cabbage – particularly Savoy**
- **Brussels sprouts**
- **Broccoli**
- **Red peppers**
- **Garden peas**
- **Fresh rosemary**
- **Onions, leeks, etc**
- **Citrus fruits**
- **Supplements Di-indolemethane (DIM)[258-262]**

Eat your greens!

Eating cabbage at least once a week is reported to reduce the incidence of cancer of the colon and rectum by as much as two thirds[80] (although this has been disputed).

Brussels sprouts, broccoli and kale are probably better anti-cancer foods.

The new 'super-broccoli' will be better still.

Their theory is that eating those foods which increase levels of quinone reductase will improve our defences against free radicals and offer protection against cancer[77].

Various foods also stimulate the formation of two other groups of detoxifying enzymes – Phase 1 and Phase 2 enzymes. These are involved respectively in breaking down dietary carcinogens and toxins, and removing them from the body.

Phase 1 enzymes are oxidative enzymes; Phase 2 enzymes make potentially dangerous compounds more soluble, so that they can be more easily excreted in the bile or in the urine.

Specific foods improve the performance of these enzymes, and improve the body's ability to deal with carcinogens.

Most scientists are concentrating on Phase 2 enzymes. The cabbage and onion families score highly here[78]. One interesting study found that the amount of genetic damage in smokers was reduced when they ate large amounts of Brussels sprouts[81].

Other vegetables which are good at inducing Phase 2 enzymes include red peppers (raw), and garden peas (raw or cooked).

Different kinds of cabbage had different effects: Savoy Rhapsody was very effective, other strains of cabbage less so. Raw basil is very effective at stimulating the body to make its own anti-oxidant enzymes, as is rosemary, which should be given pride of place in the spice rack because it is also a very potent anti-oxidant.

The best inducers of Phase 2 enzymes, however, were Brussels sprouts and broccoli, especially when eaten raw[77]. As no-one in their right mind would eat raw Brussels sprouts, I would personally choose broccoli, in a salad or served with a dip, as the most painless and effective way of getting the body's enzyme defences up and running.

I would also put onions or leeks on the menu because quercitin, a flavonoid found in high concentrations in the outer layers of leeks, onions and shallots, is a powerful enzyme inducer and anti-oxidant[82], and also is linked to a reduction in cancer risk[202].

To summarise this section – the first level in the anti-cancer strategy is to minimise exposure to carcinogens, and to strengthen the body's anti-cancer defences.

This will undoubtedly reduce the risk of many cancers – but not to zero. Some cancers will still emerge. What can enhanced nutrition do for the cancer sufferer? For one thing, it offers the prospect of cancer containment.

FOOD PREPARATION, COOKING AND STORING AFFECT NUTRITION

Dr Williamson's work showed that the breed of plant and the method of preparing the food make a big difference; and the length of storage may also be a factor. These variables are being studied, and it may soon be possible to make more detailed recommendations regarding dietary intake. It is already clear that cooked cabbage, sprouts, kale, and broccoli; mustard, radish and horseradish; citrus fruits; raw peas and red peppers are all good at upregulating the Phase 2 enzymes[77].

Anti-cancer strategy – Level 2 – Containment

Many cancer specialists no longer talk about cancer killing, but cancer management, or containment. Killing cancers with radiotherapy or drugs is still very toxic, although some clever targeting systems will make the killing strategy safer. Cancer containment is intrinsically less aggressive, and easier on the patient. The basic idea is that, if we could stop cancers growing and spreading, we could live with them.

Co-habitation with a cancer may seem scary, but if held in check, a tumour could remain in situ for years or decades – and perhaps eventually be down-graded to a minor inconvenience.

The extra-cellular matrix

All our cells are normally held in place by the three-dimensional mesh of micro-fibres known as the extra-cellular matrix (See Chapter 10, Amino sugars). If a cancer is to grow, or spread ('metastasise') from its site of origin, it must break through the matrix; and aggressive cancers do this by secreting a group of very destructive enzymes called the Matrix Metallo-Proteinases (MMPs). There are over twenty of these, and between them they break down the micro-fibres, eating holes in the matrix which

Hey Pesto!

Pesto sauce has a high basil content. And it's made with olive oil.

Blocking cancer by limiting its growth

- **Genistein, a compound found in soy beans (see Chapter 6)**
- **Sulphated glycosaminoglycans**
- **Tetrahydrocortisone, a hormone formed in the adrenals, is regarded as one of the body's natural anti-tumour agents (angiostats)**
- **Shark cartilage (see following pages)**
- **Flavolignans found in flaxseed and linseed**
- **Many flavonoids (green tea, tumeric, red wine)**
- **Lectins (soy beans)**

permit the ingrowth of new blood vessels (essential for tumour growth), and the outgrowth of cancer cells (metastasis).

Blocking the matrix metallo-proteinases is the key to cancer containment, as this strategy inhibits both cancer growth and metastasis.

Cancer growth

When a cancer first starts to grow, it can only reach the size of a pinhead before it runs out of oxygen, and starts to choke on its own waste products. To grow any further it needs its own blood supply, new capillaries to bring in oxygen and nutrients and take away the waste products.

At this point the low nutrient/high waste levels attract new blood vessels towards the cancer. Now it can start to grow very much larger[159-161].

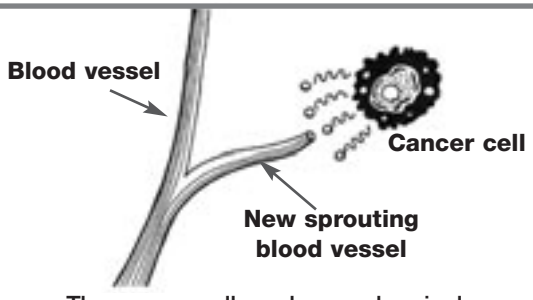
Certain compounds are able to prevent the formation of new blood vessels, thereby starving the cancer and preventing it from expanding.

These anti-growth compounds are known as angiostats. They are an enormously promising new class of natural and non-toxic anti-cancer agents[61]. One is genistein found in soy beans; another occurs in shark cartilage.

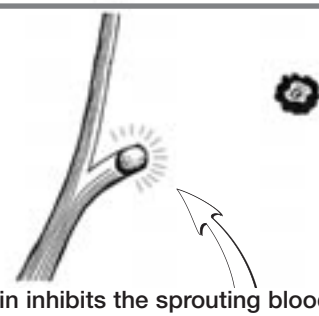
Drugs

Some drugs inhibit the growth of new blood vessels. One is thalidomide; another is captopril, which blocks many MMPs. These may become useful cancer management tools.

How genistein can block the spread of cancer



The cancer cell produces chemicals which attract the sprouting blood vessel.



Genistein inhibits the sprouting blood vessel, thereby starving the cancer and preventing it from growing.

Natural angiostats

All the angiostats now being studied in the cancer research centres stem from a natural product breakthrough made by Dr Judah Folkman at Bethesda, who did the first work with bovine cartilage extracts[159-160].

It became public knowledge in the early '90s, when marine biologist Dr Bill Lane published a book on the anti-cancer effects of shark cartilage[351]. Here's how angiostats work.

Active cells anywhere in the body use up oxygen. This reduces oxygen levels in the local tissues and causes a build-up of potentially toxic waste products. This triggers new blood vessels to grow into the area and bring in more oxygen. So as the body grows, the blood supply automatically grows in step with it.

This is why the network of arteries and veins is so beautifully and efficiently laid out. It grows exactly to where it is needed, and in the right amounts. So there are blood vessels in skin, muscle, brain, bone, lungs – every tissue in the body – with one sole exception: cartilage.

Although cartilage (the medical term for gristle) is alive, it contains no blood vessels. This is because there are chemicals in cartilage that prevent the ingrowth of new blood vessels. These inhibitory chemicals are probably there because if arteries and veins were to grow into the cartilage they would weaken it.

This offers a completely new approach to the treatment of cancer.

While you are growing, the blood system grows with you. But when you stop growing you stop forming new blood vessels – except in a very limited number of situations.

Firstly, in women, blood vessels re-grow inside the uterus once a month, after every period, as part of the menstrual cycle.

Secondly, the tissue regrowth which occurs in the healing process after major surgery also needs new blood vessels.

Thirdly, there is some regrowth of blood vessels after a heart attack. And finally, there is cancer.

In adults, cancer cells represent a new localised area of tissue growth. As the cancer cells grow and multiply, their metabolic activity reduces local oxygen levels, and increases local levels of waste products.

Cartilage has no blood vessels

As a cancer grows it needs new blood vessels.

All body tissue has blood vessels supplying it – except cartilage, which contains compounds that inhibit blood vessel growth.

That's why cartilage extract is being used to slow tumour growth.

The lens of the eye is the only other tissue without blood vessels – and may contain similar compounds.

Sharks have 10 times more cartilage than mammals

Cartilage makes up six per cent of a shark's body weight, compared with less than 0.6 per cent in cows and other mammals. Compared to fish, they are relatively immune to cancer.

This stimulates the ingrowth of new blood vessels. With its own blood supply established, the cancer can really take off[159-161]. (If you film a tumour using time-lapse photography, you see all the nearby blood vessels sending offshoots towards the tumour, as if they were drawn in by a magnetic field. When they arrive, tumour growth accelerates.)

This was why, back in the ’70s, researchers wanted to test substances that might stop the growth of new blood vessels. They thought that bovine cartilage might be a good place to look. Their hope was that cartilage extracts could stop the formation of new blood vessels, and starve cancers to death.

No side effects

The beauty of angiostats is that they don’t affect any other part of the body, except in those few situations where new blood vessels are forming.

Compared to orthodox chemotherapy, angiostats are remarkably free from side effects.

The first results were positive[352-354]. When cartilage extract was given to mice and rabbits, the growth of new blood vessels towards tumours stopped, and tumour growth was halted, with no toxicity. But although bovine cartilage clearly contained angiostat compounds, they were only present in very small amounts. It took a half kilo of cartilage to make 1 milligram of active compound. Because cancer patients would require about 10 grams of the active compound per day, a drug company would need to process 5,000 kilos of cow cartilage per patient, per day.

It was at this point that the shark made its contribution. Although most fish suffer from cancer just like any other higher life-form, sharks are nearly immune to cancer. It is perhaps no coincidence that sharks have skeletons composed entirely of cartilage.

Angiostats are not panaceas

Angiostats, whether natural or synthetic, work best to help suppress breast, cervical, prostate and other solid tumours, rather than leukaemias and lymphomas.

The research group started with cartilage from the 20-foot long basking shark, and obtained positive results. The first assays revealed that shark cartilage was an extremely rich source of the angiostat factor, containing over a thousand times more of the compound than cow cartilage[355]. The researchers realised the importance of their findings. Other labs duplicated the results[62-66,127,128,356], and the rest of the medical profession began to take an interest.

A few doctors started to give shark cartilage extract to some of their ‘hopeless cases’. In a few of these patients, the tumours shrank and disappeared. Patients who had been given up for dead, recovered. Sceptical clinicians became converts. As a result, further research into angiostats is now under way.

Shark cartilage and the soy compound genistein appear to attack cancers in a highly specific manner, and at one of their weakest points. The blood supply to a tumour is much more fragile than a normal blood network. The vessels are thin and incomplete, constantly breaking down and constantly needing to be replaced. Anything which inhibits the formation of new blood vessels is going to hit the tumour very hard.

But this approach won't treat every cancer. Breast, cervical, prostate, brain, and other solid tumours are likely to be the best targets. Lung cancer is unlikely to respond well, because lung tissue is so rich in blood vessels that a tumour could simply cannibalise the vessels already in the vicinity. Leukaemias and lymphomas are also unlikely to respond to this type of treatment, as they are less dependent on new blood vessels in their development.

HOW EFFECTIVE IS SHARK CARTILAGE?

Some scientists dismiss oral shark cartilage supplements because the proteins in shark cartilage are too large to be absorbed in the gut.

However, certain cancers and many anti-cancer treatments make the gut more 'leaky' and it may be in these subjects (about one in five) that shark cartilage has an effect – although only in large (100g/day) doses.

Shark cartilage would be more effective, and work at lower doses, if it could be given intravenously. The problem with even the best oral commercial shark cartilage is that it is too dilute.

Other roles for angiostats?

Angiostats also play an important role in one other group of diseases, namely the inflammatory diseases.

Although I am not yet aware of any major trials, there are many anecdotal stories of arthritis sufferers (and arthritic pets) who have responded well to shark cartilage treatment.

Inhibition of blood vessel growth probably pays a role here; but trials have also found that shark cartilage contains substances which can modulate the activity of the immune system.

There is one more fishy story before we leave the shark, and that is to do with shark liver oil; which may turn out to be as therapeutically important as the cartilage.

Arthritis too?

In conditions such as rheumatoid arthritis, the continuing inflammation in the affected joints depends on the growth of new blood vessels into the damaged and inflamed tissues.

It seems quite logical, considering the way in which shark cartilage works, that it should also have some anti-arthritic activity.

Cartilage and auto-immune diseases

Some studies have shown that cartilage can boost the production of anti-bodies, and increase the activity of immune cells[357-361].

If shark cartilage were proven to enhance the body's natural immunity, it might eventually find a role in improving the effectiveness of vaccines.

Matrix breakdown

There are three main elements in the extra-cellular matrix: collagen, elastin, and hyaluronic acid polymers.

The matrix metallo-proteinase enzymes (MMPs) include enzymes which break down collagen (collagenase), elastin (elastase), hyaluronic acid (hyaluronidase) and gelatin (gelatinase).

There are over 20 MMP enzymes known.

Shark liver oil is a rich source of a peculiar group of compounds called alkoxyglycerols. These compounds occur in small quantities in many natural sources, including bone marrow, and human breast milk.

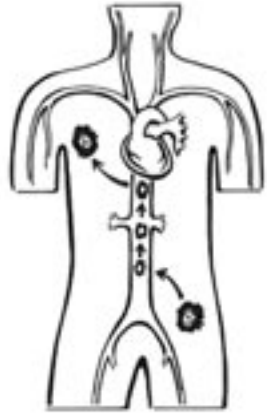
Alkoxyglycerols have a number of interesting properties. A Swedish team have shown that they stimulate the formation of antibodies after immunisation[362, 363]. They also help to minimise the suppression of bone marrow which occurs after radiation therapy[362, 364, 365]. They have been shown to protect against radiation injury caused by radiotherapy for cancer, especially when given prophylactically, ie in advance[366, 367]; when shark liver oil is given to cancer patients before radiation treatment, tumours are harder hit and mortality is reduced[367].

The shark has long been feared as the most ruthless and efficient of predators. But it looks as if the shark and its cousins, the skates and rays, may make an important contribution to the nutritionally based medicine of the future.

Cancer spread

The process of new vessel growth is complex, and can be blocked at several points. The matrix metallo-proteinases (MMPs) are an obvious target, as if there are no holes in the extra-cellular matrix there is nowhere the new blood vessels can grow. The other reason for targeting the MMPs is that they are equally involved in metastatic spread.

Metastasis



Cancer cells can break away from a cancerous site and travel via the blood-stream to other parts of the body.

There they can attach themselves and start a new cancer or metastasis.

It's rather like the dispersal of seeds.

If a cancer is to metastasise, it must first attach to and then break through the extra-cellular matrix that would otherwise hold it in place. In order to do this, cancer cells secrete MMPs; the more MMPs a cancer secretes, the more invasive it becomes[126, 155].

These enzymes are so destructive that if a cancer cell tried to secrete them in active form, it would blow itself apart.

Instead, it secretes a form of the enzyme which is blocked with a sort of safety catch.

Once the inactive enzyme has been safely pushed out of the cancer cell, a second group of enzymes, called proteases, strip off the safety catch, and activate the matrix metallo-proteinase enzymes.

Cancer containment – a nutraceutical approach

The process whereby a cancer spreads can be blocked at a number of stages, using different food extracts.

Firstly, the rate of MMP production in cancer cells can be reduced by extracts (technically lectins) derived from the elderberry plant[236]; and by flavonoids such as the citrus flavonoids[237].

Secondly, the proteases responsible for activating the MMPs can be blocked by protease inhibitors such as the Bowman Birk compound (another lectin), which occurs in high levels in soy beans (see pages 202-203). These first two steps reduce both the amount of MMPs, and the degree of MMP activation.

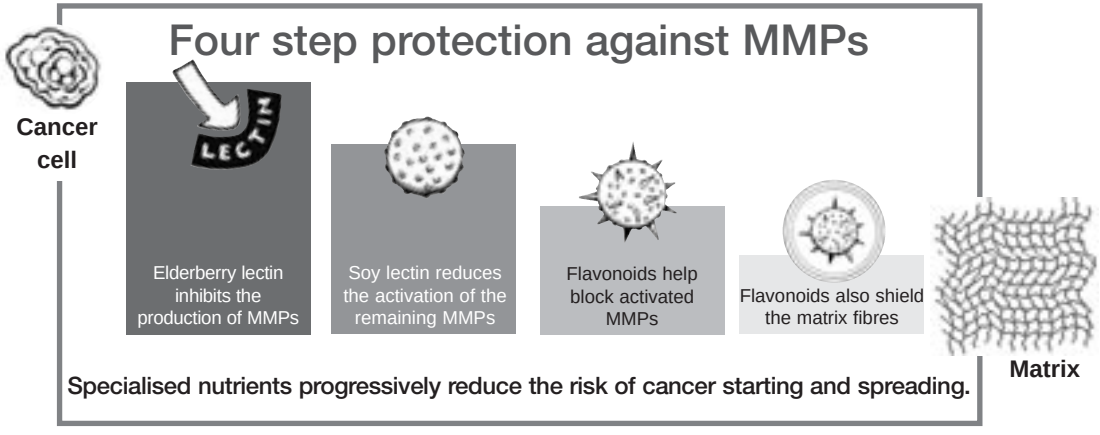
Thirdly, those MMPs which have been activated can be blocked by various flavonoids. Some have the ability to bind the zinc atom at the heart of the MMP enzymes, others may block the enzymes' active site by bonding to specific amino acids on the site.

Fourthly, those activated MMPs which remain active can be prevented from attacking the matrix with flavonoids, which bind to elements in the matrix and shield them from enzyme attack.

Breast cancer risk

The protease/metallo proteinase story is very complex. Some MMPs, once activated by a protease enzyme, go on to activate other MMPs, so that the initial release of inactive precursors becomes a self-activating cascade of destructive enzymes.

The actions of lectins and flavonoids, therefore, overlap somewhat; but this does not invalidate the general scheme shown in the box below.



How flavonoids block MMPs

1. **MMPs require an atom of zinc to function – and many flavonoids can chelate (bind) this metal.**
2. **Flavonoids also bond to the amino acids proline and hydroxyproline. If these amino acids are in or near to the MMPs' active site, this will impair the enzyme's function.**
3. **Proline and hydroxyproline are also present in the micro-fibres of the extra-cellular matrix. Flavonoids bonding here effectively shield the fibres from the MMP enzymes.**

How effective is this nutraceutical approach to cancer management? The evidence is persuasive: for example, one group of flavonoids (termed proanthocyanidins) cause 100 per cent inhibition of key MMPs[74] at levels which are achieved in the body by taking grapeseed extract supplements, or by drinking 1/2 to 3/4 litres of red wine per day. This could explain the recent findings that red wine drinking is associated, not only with a reduced risk of cardiac deaths, but also of deaths from all causes[186-191].

Red wine contains the particular flavonoids resveratrol, which has a wide range of anti-cancer properties[241]; and catechin. In one particularly exciting experiment, when high dose red wine extract was given to cancer-prone mice, their life-span increased by 50 per cent or more[242].

In my experience, this group of flavonoids has the ability to stop even the most aggressive cancer cells in their tracks, at least in laboratory experiments[238]. What is more, these compounds achieve significant levels in the tissues, including the brain[239] – and they are non-toxic.

Other flavonoids which are almost as effective as the proanthocyanidins at blocking MMPs include luteolin, apigenin, kaempferol and silybin; and some of these have been shown to reduce cancer cell invasiveness also[185]. Olive oil, too, can inhibit MMP activity[240], and this is an important element in the health-promoting Mediterranean diet.

Add to the anti-cancer regime the soy-derived protease inhibitors, and the elderberry extracts which reduce MMP synthesis, as in the diagram on page 213; and one might hope to stabilise even the most aggressive, invasive cancers. Individual case histories have been extremely positive.

Where cancer blockers come from

Many growth inhibitors and angiostats are derived from natural food sources.

Soy beans, for instance, contain genistein, which is a powerful angiostat. When people eat a reasonable amount of soy protein, levels of genistein in the blood reach the levels which inhibit cancer growth in vitro[67, 68, 129], and force cancer cells back towards more normal behaviour[134] (known as redifferentiation).

Various experimenters have shown that genistein and other soy compounds are effective in suppressing the growth of breast cancer[131, 132, 139]; prostate cancer[137, 138]; colon cancer cells[133]; and leukaemias[130, 135, 136].

Soy is so much more widely consumed in Japan than in the West that levels of genistein in the urine of Japanese men and women are 30 times higher than in Westerners. This means that their blood and tissue levels are also much higher – probably high enough to keep many cancers in check. This would explain the four to fivefold increase in prostate and breast cancers in Japanese who relocate to the USA. They are no longer eating soy as a staple, and any cancer lurking in the body but being kept in check by the genistein, is suddenly free to grow[76].

Soy also contains at least five protease inhibitors, which prevent the activation of the matrix metallo-proteinase enzymes[76].

One of these is the Bowman Birk protease inhibitor. This important therapeutic molecule is rapidly absorbed from the gut, achieves significant tissue levels and has been demonstrated to have strong anti-cancer effects[70, 251-7].

Consider also blackcurrants, and the perennial herb Lady's Mantle. These plants contain flavonoids which are potent inhibitors of the metallo-proteinase enzymes, including the elastases, hyaluronidases, gelatinases and collagenases[71, 72, 74].

Don't forget ginkgo and pycnogenol. These contain flavonoids which are very good at stabilising collagen and elastin fibres and protecting them from enzymic attack – an equally important anti-cancer property[73, 75, 123-125, 185-191]. But for optimal cancer control, flavonoids should be combined with appropriate lectins and carotenoids.

Cancer-controlling carotenoids

The carotenoids – beta carotene is the best-known example – are a family of plant compounds which produce the yellow, orange, pink and red colouration in foods such as carrots, apricots and squashes.

They are anti-oxidants, which explains their ability to protect

Cancer blockers:

- **Soy beans and soy products**
- **Blackcurrants, elderberries**
- **Ginkgo**
- **Alpha-carotene**
- **Lycopene**
- **Flaxseed**
- **Green tea**
- **Grapeseed extract, raspberries**

LOOK FOR ...

a supplement that includes an angiostat (eg 40-100mg of soy isoflavones) that will help restrict blood supply to incipient cancers; plus flavonoids (especially from berries) which help block MMP enzymes and protect the

against macular (eyesight) degeneration and coronary artery disease[193-195, 220] – a high lycopene intake appeared to reduce heart attacks by 40 per cent in the recent Euramic Study[295]. They are immuno-enhancing agents. They also have the special property of improving communications between cancer cells and normal cells, which is thought to force cancer cells to revert to normal behaviour[50, 83-86, 89].

Beta carotene and lung cancer

The relationship between beta carotene and lung cancer is particularly complex. A high beta carotene intake **reduces** the risk of lung cancer in non-smokers, but **increases** the incidence of lung cancer in smokers (shown by the ATBC[156] and CARET[213] studies).

The most persuasive explanation for this unexpected finding is that, under certain circumstances, beta carotene (in common with all carotenoids) becomes pro-oxidant and harmful.

This is most likely to occur when there are high concentrations of beta carotene, oxygen and free radicals, local tissue damage and, critically, low levels of Vitamin C. This is a precise description of the lungs of a smoker taking beta carotene supplements.

Carotenoids, as with Vitamin E, must not be taken without a Vitamin C foundation. When safely combined with Vitamin C, carotenoids should give pronounced health benefits to smokers and non-smokers alike. However, until further research clarifies the situation, it is wise for smokers **not** to supplement with beta carotene.

A novel anti-cancer effect

Mixed is best

Mixed natural carotenoids (ie not just beta carotene, but alpha carotene, lutein, lycopene[261], crypto-xanthin, etc.) can persuade cancer cells to revert to normal. Always combine with Vitamin C and selenium.

Many carotenoids have the ability to inhibit cancer development at low, non-toxic doses. The inhibition is generally reversible, so that, when the carotenoids are withdrawn, the cancer begins to grow once more. (Translated into dietary terms, this emphasises the importance of long-term nutritional prevention/maintenance regimes, rather than short-term treatment.)

Technically, the strength of this anti-cancer effect is related to the ability of carotenoids to improve inter-cellular communication; and to increase synthesis of connexin 43 (C43) protein, which forms part of the gap junction between cells[51, 52, 321, 322]. Increased C43 synthesis is strongly linked to growth control, and the suppression of neoplastic growth[83-86]. Cancer cells are deficient in terms of intra-cellular communication, C43 protein and contact inhibition. Carotenoids can return these parameters to near-

normal, and work best when combined with selenium, which is an essential element in C43 protein.

This is probably why the carotenoids can induce cultured cancer cells to revert to normal behaviour patterns[50, 89]. This finding is reflected in animal and clinical studies, where carotenoids have been used to prevent the development of pre-cancerous conditions in the upper respiratory tract, mouth, gut and cervix, with some success[16, 26 ,34, 83, 88, 92, 93, 283, 286, 296,304].

This potentially vital anti-cancer action is probably not a retinoid effect; the evidence suggests that carotenoids possess an intrinsic ability to regulate the key growth controlling genes[91, 173, 203, 276, 277, 294].

This would explain why high carotenoid levels in the diet are linked to a reduced risk of cancer in the stomach, oesophagus, cervix, throat and lung[8, 11, 17, 33, 87, 90, 176, 209, 278 ,281 ,287, 303]. But which carotenoid?

Many studies which found a lower cancer risk with a beta carotene rich diet were actually measuring the effect of a diet rich in fruits and vegetables, which contain a range of carotenoids and other potentially therapeutic compounds. In the last few years it has become apparent that beta carotene, *by itself*, appears to offer relatively little protection against cancer[156, 213, 218, 219, 221, 271, 272, 291, 292, 302, 312].

Limits to growth

Normal cells have C43 proteins on their surfaces. As they multiply the C43 proteins come into contact with C43s on other cells and this stops further growth. This is called cell contact inhibition.

Cancer cells have few or no C43s, so their growth is uncontrolled.

Selenium depletion impairs C43 function, which may be why it is linked to an increased risk of cancer.

Why organic foods are better cancer protectors

Protease inhibitors and flavonoids in soy beans and other plants (including tomatoes and potatoes) are part of the plant's defence system against insect predators.

For example, protease inhibitors stunt the growth of the insects and reduce the amount of plant consumed.

It's a generalised response. Even if only one leaf has been attacked by an insect, the plant begins to build up levels of its defence compounds throughout its leaves, shoots and other parts.

If the protease inhibitors and flavonoids are important in reducing our risk of cancer, it may therefore be healthier for us to eat organic food, which is exposed to more insect attack; because the plant will have developed higher levels of these defence compounds.

Immaculate fruits and vegetables, unblemished by insect attack, which are produced by intensively sprayed crops and designed for the supermarket shelves, are likely to contain less of the compounds which may be critical to lowering our cancer risk.

Genistein, the isoflavone in soy, also has anti-cancer properties. Genetically modified soy appears to contain less genistein – another argument for organic foods?

Cancer cell suicide

Most re-differentiators can also force cancer cells to commit suicide. Lycopene is particularly good at this, as is resveratrol, the flavonoid found in raspberries, grape skins and red wine. Resveratrol does this by blocking NF-Kappa B, a protein made in the body which would otherwise protect the cancer cells.

High doses (ie over 25mg lycopene a day or over 250mg of resveratrol) have demonstrated significant anti-cancer effects in animal models and clinical trials.

They probably should not be considered with high dose PUFAs (see pages 207-210), as they are anti-oxidants and could reduce the PUFAs' ability to kill cancer cells via oxidative stress.

Lycopene – a strong anti-cancer carotenoid

The fact is that when researchers tested beta carotene, they probably picked the wrong carotenoid. Beta carotene is not as potent an anti-cancer agent as alpha carotene[199, 200], lutein or lycopene[314]. These carotenoids occur in some of the same foods as beta carotene, so the surveys which showed that a diet rich in beta carotene reduced the risk of cancer, were probably measuring the protective effects of other carotenoids, such as alpha carotene, found in carrots; and lycopene, found almost exclusively in tomatoes[318].

Of all the carotenoids found in human tissues, lycopene tends to have the most potent anti-cancer properties on a variety of human and other cancer cell lines in vitro[300, 315, 320].

In clinical studies, lycopene has been linked to a significant degree of protection against cancers of the gastrointestinal tract[282], breast[274, 323], the cervix[311, 319] and especially of the prostate[290]. In this context, it is probably relevant that lycopene is stored in the body in the testes, adrenal and prostate [279, 280, 317].

In sum, the balance of the evidence now available indicates that lycopene is an important micro-nutrient, and among the most potent anti-cancer dietary factors yet discovered[95-98, 288, 289, 309, 325-329].

Pasteurised tomato juice and tomato paste are good sources of lycopene, and have been shown to boost lycopene levels in the blood. Uncooked tomatoes do not have much effect, as the lycopene they contain is locked up inside the plant cell walls, and is unavailable for absorption[316].

Pass the ketchup!

Tomato concentrates appear to offer protection against breast and prostate cancer, and are being used to treat prostate cancer in two ongoing trials.

Anti-cancer strategy – Level 3 – Killing

Cancer management as described in the preceding section may be able to hold many cancers in check for years, perhaps indefinitely. And it is very likely that some cancers managed in this way, starved of nutrition, unable to spread and forced to re-differentiate, will eventually die off. Other cancers however may persist, or become resistant. If this happens, cancer killing may become the only option – and nutrients have a role to play here too. Fish oil may be among the most important of these.

PUFAs are found in high concentrations in the membranes of all our body cells, in the form of phospholipids. They are very prone to being oxidised by free radicals[17].

When a PUFA molecule is oxidised it becomes a PUFA radical. This starts a chain reaction, oxidising other PUFAs into PUFA radicals. A chain reaction quickly becomes a cascade and, if not stopped, it kills the cell[20].

This doesn't usually happen, because anti-oxidants such as Vitamin E block the chain reaction. Another 'fire break' is that PUFAs in the membranes are kept apart from each other in separate compartments. But if the compartment bulkheads are damaged, and the PUFAs come into contact with one another, the chain reaction takes off and they all oxidise very rapidly indeed[17].

Cancer cells are different from normal cells in many respects, but one of the crucial differences is that they have sub-normal levels of PUFAs in their cell membranes[50-52].

They don't seem to be able to handle PUFAs well. If they are 'fed' on PUFAs, they produce more than normal amounts of PUFA radicals[19], because they are unable to protect them from oxidation in the way that normal cells do.

This isn't because they have less anti-oxidants. In fact, cancer cells tend to have above normal levels of Vitamin E and/or beta carotene[23-25, 180], and increased levels of the main anti-oxidant enzymes too[57, 58].

The reason why they cannot prevent the PUFAs in their membranes from being oxidised may be because the bulkheads that keep PUFAs apart in normal cells are not doing their job in cancer cells[26].

When levels of free radicals begin to increase inside a cell, they stop cell division. When they increase further, they trigger a cascade of radical formation that either makes the cell commit slow suicide, or kills it outright. And because cancer cells cannot store their PUFAs safely, so that they form PUFA radicals, they are uniquely vulnerable to PUFAs in their environment, or in your diet.

This may mean that many cancer cells self-destruct in a blaze of PUFA free radicals long before they can become a health problem.

Fried tomatoes

To obtain maximum benefit from tomatoes, use deep red tomatoes, which have the highest lycopene content. Then fry them in olive oil.

This makes their lycopene content more bio-available.

Cancer killing

Many flavonoids and carotenoids are capable of killing cancer cells, if used in large doses.

PUFAs trigger self-destruction in cancer cells

Cancer cells can be made to self-destruct if given high-dose poly-unsaturated fatty acids.

Most studies have used fish oil, rich in Omega 3 PUFAs. There is some rationale also for using an Omega 3: Omega 6 combination; a ratio of 1:2 – 1:3 may be best, which is the ratio in hemp oil.

It also means that, by definition, any cancer cells that survive and multiply for long enough to become a tumour must have learned, somehow, to protect themselves against PUFA oxidation.

Omega 3 daily

A daily Omega 3 supplement should form part of your anti-cancer strategy. Most people already eat enough Omega 6.

PUFA RADICALS

PUFA radicals may be more than mere agents of destruction. There is good evidence that the level of PUFA radicals is a critical signalling factor. Levels of PUFA radicals inside the cell go down just before the cell begins to divide, and may even be responsible for triggering the beginning of cell division[20-22].

This is completely logical because, when the cell divides, its DNA becomes extended, unshielded and very vulnerable to free radical damage. So a cell naturally wants to increase its anti-oxidant defences before the division process starts. This is probably why rapidly dividing tissues (like cancer cells) tend to have higher than normal levels of anti-oxidants[41].

Removing cancer cells' defences

Limiting radio-therapy damage

To prepare for a course of radiotherapy or chemotherapy, stock up on high quality fish oil and evening primrose oil, with Vitamins C and E and red wine or red wine extract to minimise collateral damage[231].

A combination very like this is already being used in Europe to increase the effectiveness and safety of radiotherapy.

In fact, the potentially explosive PUFA chain reaction is so dangerous to cancer cells that they appear to have developed at least four different defences against them.

Firstly, they increase their levels of anti-oxidants such as Vitamin E[23-25]. Secondly, they have higher than normal levels of anti-oxidant enzymes[57, 58]. Thirdly, they tend to take up fewer PUFAs than normal cells[26]. And fourthly, the majority of cancer cells have reduced levels of PUFA synthesis[27-30].

These four steps all combine to reduce the levels of PUFAs and PUFA radicals in successful cancer cells. The better they are at keeping their PUFA levels down, the more malignant and metastatic they tend to be[31-35, 60].

If, on the other hand, you load cancer cells with PUFAs, their anti-oxidant defences are overwhelmed[142] and they self-destruct[42].

This theory predicts that pro-oxidants like iron and copper should increase the ability of PUFAs to kill cancer cells – and this does appear to be the case[43-48].

Cancer specialists will recognise this pattern, because many anti-cancer therapies work by generating free radicals inside the

cancer cells. As you might expect, cancer cells 'force-fed' on PUFAs become much more vulnerable to the free radical damage caused by orthodox anti-cancer drugs[18].

WARNING

Short courses of high-dose PUFAs may have significant anti-cancer effects. But long-term self-dosing with large amounts of PUFAs is not recommended, unless combined with high-dose anti-oxidants.

PUFAs are very susceptible to oxidation, which is why they are always, in nature, found combined with anti-oxidants. Plant sources of PUFAs, for example, are also good sources of anti-oxidants such as Vitamin E, which the plant uses to stop its PUFAs from going rancid.

If you take supplements of fish or plant oils without taking high-dose anti-oxidants, you are exposing yourself to increased free radicals, as well as potentially dangerous lipid oxidation products[53], which are toxic to the heart and blood vessels (see Chapter 8, Essential fatty acids).

3:1

Human cell membranes contain Omega 6 and 3 fatty acids in an approximately 3:1 ratio – as does human breast milk.

Which PUFAs?

It depends on which scientists you talk to. There is some evidence that the Omega 6 PUFAs in plant oils are potentially useful anti-cancer agents[38-40].

On the other hand, some animal experiments have shown that whereas the Omega 3 PUFAs in fish oil inhibit tumour growth, high levels of linoleic acid (an Omega 6 PUFA) can have the reverse effect[54-56].

The picture is not entirely clear, but some lipid specialists believe that the Omega 3 fish oils may be a better bet than the Omega 6 plant oils. Omega 3 oils have been shown to slow the growth of cancers in the lung, stomach, colon and pancreas[59, 223].

There is also some evidence of a decrease in cancer risk as the Omega 3/Omega 6 ratio in the diet increases (see Chapter 8, Essential fatty acids) – although the data are not entirely consistent.

Remember to combine Omega oils with Vitamin E

Treat high doses of fish oils or plant oils with care. Animals fed a high PUFA diet long term have an increased risk of cancer, and a shorter life expectancy – **unless** they are given Vitamin E supplements as well[53]. Vitamin C should also always be taken.

THE PUFA STORY IN BRIEF ...

The story is a complex one, so let me recapitulate.

- PUFAs are not generally toxic to normal cells.
- Normal cells take up more PUFAs than cancer cells but don't oxidise them to nearly the same extent.
- Normal cells have less anti-oxidants than cancer cells, so they are somehow storing or compartmentalising the PUFAs in a safer and more controllable manner.
- Whereas normal cells are vulnerable to PUFA shortages, cancer cells are vulnerable to too much PUFA, as they cannot shield them from oxidation.
- When normal cells are irradiated, the degree of tissue damage is reduced by PUFA replacement therapy[49]. This is because much of the damage they suffer is due to PUFA shortage, caused by the radiation.
- When cancer cells are irradiated, more of them are killed after pre-incubation with PUFAs – because toxic free radicals are formed.

PUFAs in action

The vulnerability of cancer cells to PUFAs has been shown in a variety of experiments. For example, cancer cells in a Petri dish normally grow over and swamp normal cells. If you add high-dose PUFAs, the reverse happens[34], and the normal cells replace the cancer cells.

The next step is animal experiments and, fairly recently, GLA, an Omega 6 PUFA found in plant oils, was shown to inhibit the initiation and growth of human cancers transplanted into mice[36, 37].

Even more recently, the first trials of high-dose GLA in human cancer produced some promising results.

In one study, involving cases of advanced and inoperable pancreatic cancer, increasing doses of GLA produced a significant increase in the length of survival of these terminally ill patients[38-40].

Other scientists have shown that the Omega 3 PUFAs in fish oil inhibit the growth of cancers of lung, stomach, pancreas and colon[141, 142].

Further work is in progress to clarify the role of PUFAs in cancer therapy.

Anti-oxidants – a two-edged sword?

Cancer cells, as we have seen, are very vulnerable to PUFA radicals. Any cancer cell which survives to multiply and become a tumour has, by definition, been able to survive such oxidative stress, by increasing its levels of anti-oxidants and decreasing PUFA uptake.

So what happens if you take massive doses of anti-oxidants? Could these help more early cancer cells survive?

In cancer cells, as we have seen, the levels of anti-oxidants, including Vitamin E, are often higher than normal. Cancer cells need high levels of anti-oxidants to keep levels of free radicals low. This may be partly because their high division rate makes their DNA very vulnerable to free radical damage, and partly because of their inability to store PUFAs safely.

So a cancer, once initiated, **might** do rather well on anti-oxidant supplements which offer it additional protection, particularly if the anti-oxidants used had no intrinsic anti-cancer properties (as the carotenoids and flavonoids do). This may mean, for example, that Vitamins C and E might in some circumstances be counter-productive.

This alarming prospect cannot be entirely dismissed, and I believe it needs to be properly examined.

Before you throw away your supplements, bear in mind that certain anti-oxidants (beta carotene, Vitamins A, C and to some extent E) can be very effective in treating pre-cancerous conditions in the throat, larynx and the gut[7, 8, 140, 208]. Beta carotene can suppress the growth of cervical cancer cells, and cause them to self-destruct[9], although it is less effective than lycopene (see lycopene section on page 206). There is also evidence that an increased beta carotene intake is linked to a reduced risk of cervical cancer[10].

However, the optimal time to start taking most anti-oxidants is before a cancer has started. DNA damage caused by oxidation is an important cause of cancer and a recent study showed conclusively that supplements of Vitamins C, E and beta carotene (at 100mg, 280mg and 25mg a day respectively) reduce the amount of oxidised DNA in smokers and non-smokers alike[204].

Nevertheless, there is at least one small trial which suggests that anti-oxidant supplements may have a protective effect even after a cancer has started. In patients who had undergone surgery for bladder cancer, the cancer recurred in 80 per cent of the control group; but in only 40 per cent of those who took high doses of multivitamins including A, C, E, the B group vitamins and zinc[11].

Beta carotene – for non-smokers only

New work shows that if beta carotene is oxidised (as occurs in the lungs of smokers) it may become a pro-oxidant and a carcinogen[197].

Smokers should not take beta carotene.

On the balance of evidence, however, they should continue to take other anti-oxidants, including mixed carotenoids and Vitamin C.

Add anti-oxidants

High-dose anti-oxidants may make cancer treatments more effective[115-117].

The conclusion so far …

Anti-oxidants can help reduce the risk of cancer if it has not already started[174].

But if there is a pre-existing (pre-clinical) cancer, high doses of some anti-oxidants **might** increase the chances of the cancer growing and becoming a clinical problem.

Not all anti-oxidants are the same. High-dose Co-enzyme Q10 or Vitamin K are more likely to kill or suppress cancer cells, by blocking cytokine synthesis[198, 212].

High-dose carotenoids, flavonoids and isoflavones also have well-documented cancer cell killing properties.

However high dose tocopherols (Vitamin E) and carotenoids become cytotoxic once they have themselves been oxidised. If used in this way, they should not be combined with Vitamin C or flavonoids, which would otherwise refresh them (see page 63).

At the time of writing, the picture is confused. There is simply not enough data to say whether anti-oxidants can encourage cancer growth or not.

Ongoing trials may help to settle the argument. In the meantime, it may be wise to assume that the relationship between anti-oxidants and cancer could be more complex than we thought.

If anti-oxidants are taken before a cancer has started, and perhaps also while the immune system is fully functional, most data suggests that this is a good thing, and will reduce the risk of cancer and other free radical mediated illness. But if anti-oxidants are taken later in life, it is conceivable that some of them may, under certain circumstances, increase the risk of cancer.

This suggests that it's fine to start taking anti-oxidants at any time up to your late 40s, or 30s if you are a heavy smoker. After this time it might be wise to add a little nutritional insurance.

If there is a possibility of a pre-existing cancer, it might be better to deal with it before beginning anti-oxidant therapy.

One (controversial!) way of doing this would be to take an immuno-stimulant and pro-oxidant package. This would combine broad-spectrum supplements with echinacea and high-dose PUFAs *without* anti-oxidants. It might even include an oxidising agent such as hydrogen peroxide or even hydrazine (the rocket fuel), both of which have been used by some practitioners. This should force some cancer cells to self-destruct. Of course, this approach is for professionals only, and *not* for self-medication.

After an initial oxidative phase, during which hopefully the cancer is knocked back, the logical next step would be PUFA replacement combined with anti-oxidants to replace the PUFAs which were destroyed in healthy tissues.

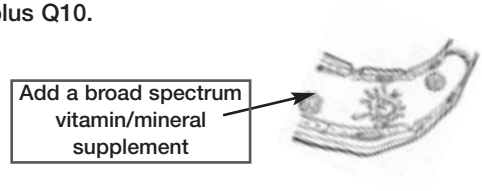
A Six Step Defence Plan against Cancer

The six-fold strategy below is progressive. The first two steps are preventative. The subsequent four steps 'manage' cancer. At each of these steps some cancer cells will be deactivated, neutralised or destroyed. The function of each subsequent step is to deal with any remaining cancer cells that the previous step did not overcome.

Cancer avoidance

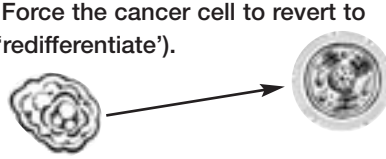
Step 1 Reduce free radical damage to DNAs with anti-oxidants, and upregulate anti-oxidant and Phase 2 enzymes with plant foods, ie increase fruits, nuts, vegetables and grain in your diet.

Step 2 Support the immune system with a broad spectrum vitamin/mineral supplement, plus Q10.



Cancer containment

Step 3 Force the cancer cell to revert to normal ('redifferentiate').

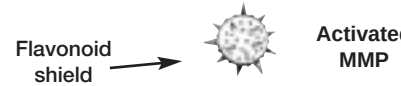


Soy isoflavones like genistein and daidzein, can do this, as can carotenoids like lycopene and alpha carotene, and flavolignans in flaxseed.

Step 4 Block the proteases that would otherwise activate the MMP enzymes that destroy healthy tissue (see page 93).

Lectins found in beans, especially soy, do this very effectively[251].

Step 5 Block the activated and now highly destructive MMPs that breakdown the body tissue. Some flavonoids can do this directly.



The flavonoids found in bilberry and grapeseed 'coat' and therefore shield the individual fibres of the body's cellular matrix against the MMPs (see Chapter 6, Flavonoids & isoflavones).

The MMP blockade will also choke off the blood supply to the cancer. Genistein, other flavonoids and cartilage extracts are all good angiostats – as are the drugs thalidomide and captopril.

Cancer killing

Step 6 Kill the cancer cell by ultra high-dose Omega 3 possibly with a pro-oxidant. Very high doses of flavonoids can also kill cancer cells as can the carotenoid lycopene and the isoflavones (but see box on page 206).

Increase your ORACs!

Scientists at the Human Nutrition Research Centre at Beltsville, Maryland, are now measuring how effective individual foods are in neutralising free radicals. They give the foods ORAC scores – standing for Oxygen Radical Absorbency Capacity.

ORAC scores rise with high intakes of fruit and vegetables, especially those on the list opposite.

Fruits with the highest ORAC scores, so far, in rank order are prunes, raisins, blueberries, blackberries, strawberries, raspberries, plums, oranges, black grapes and cherries.

Top ORAC vegetables are kale, spinach, broccoli, Brussels sprouts and beets – each several times more potent than carrots or string beans.

Bananas and potatoes – the most commonly consumed fruits and vegetables – score low on the ORAC scale[214-216].

A broadly similar scoring system is known as FRAP. For FRAP scores of common foods see page 357.

The Anti-Cancer Diet

The anti-cancer diet is almost identical to the diets designed to protect against coronary artery disease, diabetes and obesity.

The ground rules for all three diets are:

- More fruit and vegetables
- More complex carbohydrates in grains, pulses and legumes
- Less fats, sugars, salt and smoked or pickled foods

There should be plenty of fruits, nuts, grains, legumes and vegetables on the menu, as all of these contain many different anti-cancer compounds.

Fruits are excellent sources of the anti-oxidant Vitamins A, C and the carotenoids and flavonoids. Grains and nuts are good sources of Vitamin E and the essential poly-unsaturated fatty acids and unique anti-oxidants such as avenanthramides[246-248]. Vegetables, and spices, such as rosemary and turmeric, provide not only anti-oxidant flavonoids, but also compounds which boost the Phase 2 enzymes which detoxify toxins and carcinogens.

Both fruits and vegetables provide flavonoids and carotenoids, and peas and beans, especially soy beans, are rich sources of lectins (the protease inhibitors). In addition, plant foods provide dietary fibres, which have an anti-cancer effect of their own (see Chapter 7, Pre-biotic fibre). Plant foods also provide the important B vitamins folic acid and niacin, which is important because folate and/or niacin depletion increases the risk of DNA damage[172, 178].

But which fruits and which vegetables should we eat to achieve optimal health?

The available data from in vitro work and from animal studies suggests that the following foods should be high on your shopping list[106].

Fruit, vegetables and legumes are the top anti-cancer foodsl

ANTI-CANCER FOODS

- cruciferous vegetables such as kale, cabbage, and Brussels sprouts[108, 112, 116], which may be particularly effective in protecting against colon and breast cancer
- broccoli
- citrus fruits
- tomatoes
- tea (green more than black)
- spinach
- rosemary, thyme, oregano, garlic[113-115]
- onions[117]
- soy products (which contain genistein, flavonoids and protease inhibitors[251])
- wheat or rice bran[122]
- walnuts
- raspberries, blueberries and blackberries[118, 119, 120]
- turmeric
- pears
- shiitake mushrooms[121]

Cutting colon cancer risk

An increased intake of pre-biotics (see Chapter 7, Pre-biotic fibre) together with calcium and Vitamin D [175, 176, but see also 177], will probably reduce the risk of colon cancer.

These foods will give you two out of the three important levels of protection against cancer[106], specifically:

1 Cancer avoidance

The first level prevents carcinogens from reaching their target sites (anti-oxidants, Phase 2 upregulators and vitamins and minerals to support the immune system).

AND

2 Cancer containment

The second level consists of compounds which suppress cancer cells directly (carotenoids and isoflavones); blocking or barrier agents (angiostats and matrix stabilisers); and the immuno-stimulants, which enhance the capacity of natural killer cells to attack tumours.

There are additional steps that help reduce the risk of certain specific cancers, if your family history suggests that you may be at a particular risk.

More herbs and spices

A surprising number of culinary herbs contain health-promoting substances. Rosemary is included in the good food guide

Folic acid – An anti-cancer vitamin

Researchers are now studying folic acid's role in reducing cancer risk – especially of the colon and cervix.

Many researchers now feel that a total folic acid intake of 400mcg a day – from food and supplements – is the least you need. Indeed, the RDAs are likely to be revised upwards.

Since the average intake is 252mcg, this indicates you need a supplement containing about 200mcg of folic acid.

Betaine is likely to be even more effective (see Chapter 11, Betaine).

INCLUDE

A herb element

- rosemary
- curcumin (the yellow pigment in turmeric and curry)
- thyme

Balancing act

Some food plants contain protective compounds and potentially harmful compounds. Basil (which contains estragole) was under suspicion as a possible carcinogen[243], but more recent work suggests that on balance, it is more likely to be cancer-protective[77, 105,106].

Sugar Risk

A high sugar diet increases the risk of colon cancer, and may even double it; the body responds to sugar with surges of insulin, which can promote cancer growth[334, 335]). Aspartame looks much safer!

because it contains a number of ingredients, including carnosic acid, which inhibit cancer initiation and growth in animal studies[104, 107]. Curcumin, the yellow pigment in curry and a very powerful anti-oxidant, also has a number of powerful anti-cancer properties and anti-inflammatory properties (see page 92).

Less meat and dairy foods

A high intake of fat in the diet increases the risk of colon cancer[110, 111].

There are several reasons for this. A fatty diet increases the secretion of bile salts into the gut, which are taken up by gut bacteria and converted to carcinogens such as the aromatic polycyclic hydrocarbons. These are known to be linked to liver and other cancers[213].

A diet high in fats is often low in fruits and vegetables, and therefore low in the protective factors found in plant foods. And finally, fatty diets often contain high levels of meat products – and when meats are preserved and/or cooked in certain ways (ie browned) carcinogens are formed[99].

Meat also contains iron in a particularly bio-available form, and iron is something we should be careful with. Iron can be a potent source of free radicals, causing oxidative and genetic damage (see Chapter 14, Heart disease). We have complex systems to safeguard iron in the body, but these do not always work very well[162]. There is a disease called haemochromatosis, where iron accumulates in the body; which is linked to a 200-fold increase in the risk of liver cancer[163].

In people with high body iron (but not necessarily with haemochromatosis), the risks of lung and colorectal cancer are also increased[164,166]. And in patients with diagnosed cancer, high body iron strongly correlates with decreased survival time, suggesting that some tumours grow better in an iron-rich environment[165].

As ever, the evidence suggests that we reduce our intake of animal and dairy products, and increase our intake of plant foods. In addition, take basic precautions with fats and oils: do not overheat them when cooking, don't re-use, and don't use poly-unsaturates for cooking oil (see Chapter 8, Essential fatty acids). Switch to mono-unsaturates such as olive oil; MUFAs may be less prone to encouraging cancer[109].

Die-hard carnivores could use amended cooking methods to reduce carcinogen formation. They could add ingredients such as wild rice to their meat recipes; wild rice is rich in phytates and polyphenols which bind iron, and reduce iron uptake[168].

Avoid roasting or grilling meats, because high protein foods produce carcinogens as the meat browns[99]. Steaming is fine, as are boiling, poaching, and microwaving. These cooking techniques aren't ideally suited to meats, but they are fine for fish, many of which contain Omega 3 fatty acids which have an anti-cancer effect[100-102].

If you can't bear to give up the Sunday roast, take some simple culinary precautions. Coat the meat with a mix of powdered milk and bread crumbs before cooking. This may sound odd, but the carbohydrates in milk and bread reduce the formation of carcinogens during the roasting and grilling process[103].

This is the nutritional basis for a healthy life. Supplement programmes do not replace this basis, but if you want to go further towards optimal health, supplementation should be considered.

Cooking meat

Use olive oil and add wild rice to meat recipes.

Coat meat in powdered milk and breadcrumbs.

Meat – a caution

Meat not only contains saturated fat, but iron that is easily absorbed.

High iron levels appear to be linked to a body environment that helps tumours to grow[165].

Increased iron in the gut produces free radicals – and is linked to colon cancer.

Do not consume iron oxide – often used to colour pills and supplements[69, 167].

Additional anti-cancer actions

More selenium

Selenium is essential for the immune system and has a number of potentially anti-cancer actions. The UK RDA is 70mcg/day – yet the average daily intake is 29-39mcg/day. This was highlighted in an editorial in the *British Medical Journal*, warning that the rise in cancer (which now affects four in every ten British residents!) might well be due to widespread selenium depletion[234, 235].

Larry Clark's study[234] showed that a supplement of 200mcg selenium a day (in a yeast preparation) reduced cancer of the prostate, lung and colon by around 50 per cent in a similarly selenium-depleted population in the USA. Further a recent study in London indicates that selenium can force cancer cells to commit suicide at 200mcg[250].

The PRECISE (Prevention of Cancer, Intervention with Selenium) study was set up to prove the case one way or another. Meanwhile selenium is safe at that level – so why wait?

Selenium

Selenium is essential for C43, the membrane proteins involved in cell contact inhibition and switching off cell growth. It should be combined with carotenoids for maximal effect.

TOP SELENIUM FOODS

Liver, seafood, lean meat, whole grains, oatmeal, brown rice.

Prostate – at risk!

Prostate cancer now affects one in 12 men in the UK – nearly as many as the one in 11 women who will develop breast cancer. Compared to much lower rates elsewhere, these are clear signs of dietary deficiency.

Medicines

Oddly enough, aspirin may offer some protection against cancer. The data suggest that regular aspirin consumption reduces the risk of cancer of the colon, lung and breast[158, 227]. Aspirin can force cancer cells to commit suicide and anything that encourages cancer cell death will help to reduce the risk of a clinical cancer[206,228, 229].

Typical Western consumers could also take supplements of protective micro-nutrients such as lycopene, selenium and the non-digestible oligosaccharide pre-biotics, all of which appear to reduce the risk of colon cancer (see Chapter 7, Pre-biotic fibre).

Finally they could switch from meat to soy substitutes, which are also protective against cancer (see Chapter 6, Flavonoids & isoflavones).

Reducing the risk of prostate cancer

In Japanese men who leave their home country and go to work in the USA, there is a statistical explosion of prostate cancer within the first few years of their arrival.

Some clinicians believe that this is because they are exposed to something in the American food or water which increases the risk of prostate cancer.

On closer inspection, this explanation falls down. It takes many years for a cancer to form, and it is highly unlikely that there is any ingredient in the American diet which could trigger so many cancers so fast. If there was, the incidence of prostate cancer in American men would be much higher than it already is.

It is more likely that the Japanese men had prostate cancer before they came West. While they remained in Japan, the cancers were held in check by naturally occurring growth inhibitors in the Japanese diet, probably in soy and green tea.

On relocating to the West, they lost this dietary protection and the cancers lurking in their prostates burst into malignant life.

Risk factors for this increasingly prevalent cancer are now being identified. Two recent studies indicated that Vitamin E might protect against prostate cancer[156, 224]; a third showed that selenium offered very significant protection[234]; a fourth that high calcium intake increased risk[249].

Vitamins E and D, genistein, quercitin and selenium supplements are a good bet – and offer cardiac benefits too.

Processed tomato products are strongly recommended. A recent trial suggested that the risk of prostate cancer could be cut almost in half in men who ate 10 or more servings of tomatoes per week, or by a fifth in those who ate four to seven servings a week[192].

The carotenoid in tomatoes called lycopene has important anti-cancer properties, and is capable of making cancer cells re-differentiate[225, 226] (ie normalise) or commit suicide.

Lycopene inhibits prostate cancer cells in vitro[55-60, 325-330] and is now being tested in clinical trials, which are starting to show positive results[298].

Reducing the risk of breast cancer

Breast cancer is the most important non-tobacco-related cancer in women. It is a universal problem, yet in some countries (Canada, New Zealand, Hawaii) women are 10 times more likely to develop breast cancer than in others (Senegal, Korea, Nigeria).

A few dietary factors play a large part in determining the risk of post-menopausal breast cancer. For example, a high intake of dietary fibre reduces the risk of breast cancer, while a high fat content in the diet increases the risk. At the same time, post-menopausal cancers are known to be driven by oestrogen. Why is this?

High fibre lowers oestrogen levels

Oestrogen is removed from the blood by the liver, which links it with a molecule of glucoronic acid, and excretes it in bile, into the bowel. 'Bad' bacteria in the bowel unlink some of the oestrogen, and encourage its reabsorption into the blood.

A high concentration of fibre in the bowel slows the unlinking process, reduces the amount of free oestrogen that can be re-absorbed, and so lowers oestrogen levels in the blood[144].

Large amounts of fats in the bowel, however, increase the ability of the bacteria to free the oestrogen, increase the amount which can be reabsorbed, and increase blood oestrogen levels[145].

Eat a high fibre/low fat diet

The best way to reduce your risk of breast cancer is to eat a high fibre, low fat diet (ie: predominantly vegetarian)[205,207]; and to eat fermented milk products such as live yoghurt[146, 152] (see Chapter 7, Pre-biotic fibre).

The 'good' bacteria in live yoghurt displace the 'bad' bacteria which attack oestrogen. The end result is less unlinking, more oestrogen excretion and lower blood oestrogen. The same effect would be expected with pre-biotics, which increase the numbers of 'good' bacteria in the gut (see Chapter 7 again). There is evidence that pre-biotics do indeed lower the risk of breast cancer[149]. If you don't like yoghurt, a pre-biotic product is probably more effective.

Some fibres bind more oestrogen than others[148]. The best results have been obtained with wheat fibre, which reduces blood oestrogen levels significantly – oat and corn fibre had little effect[147].

Some scientists believe that reducing oestrogen levels could increase the risk of osteoporosis[157]. This can easily be countered (see Chapter 15, Bones).

Soy, tomatoes, broccoli – and selenium

Further nutritional protection against breast cancer is gained via a healthy intake of soy products. Soy compounds block oestrogen receptors in the breast, which is one reason why a diet high in soy is linked to a greatly reduced risk of breast cancer[233]. Sulphur compounds in broccoli 'improve' oestrogen metabolism and should also be protective[263-266].

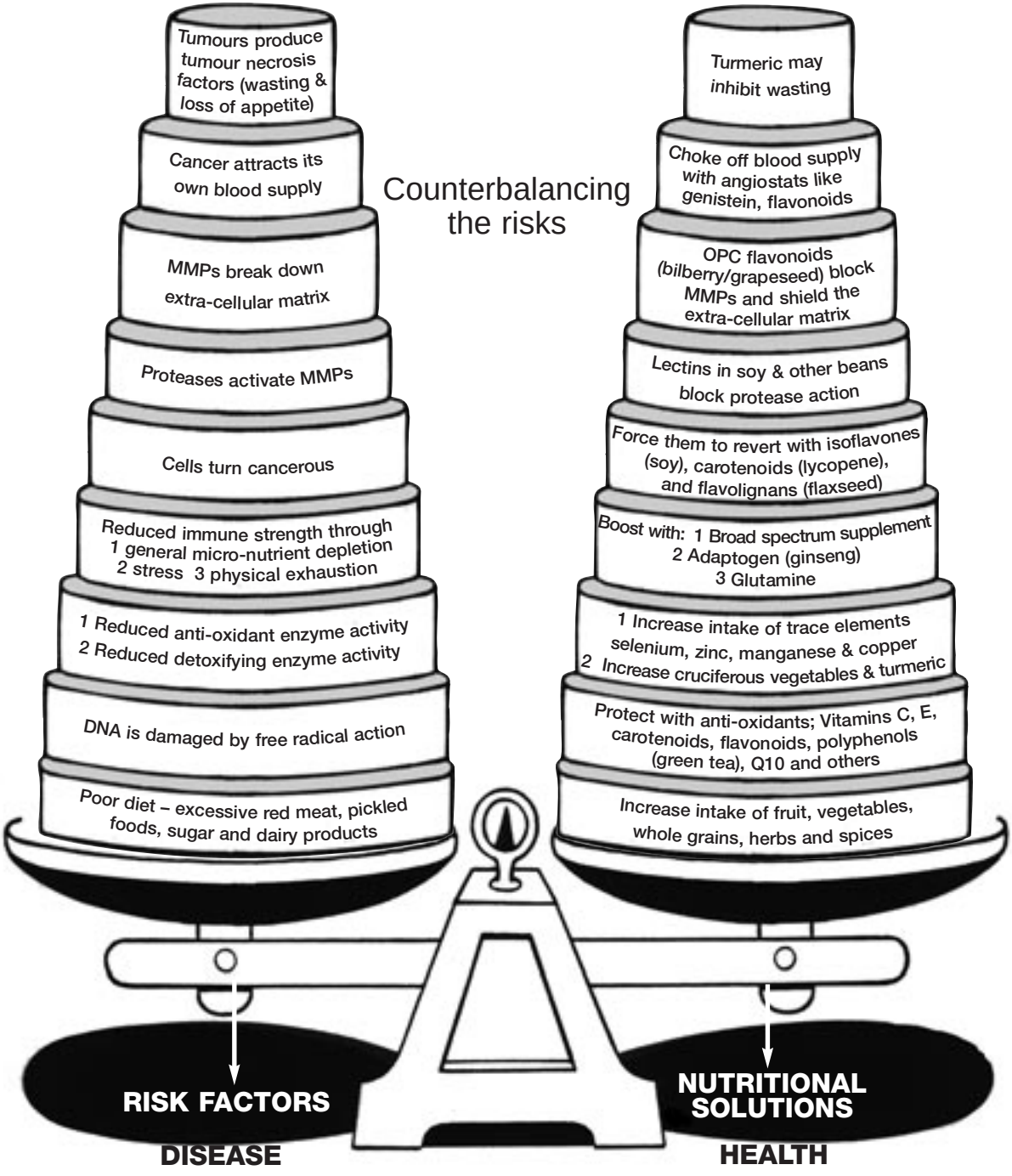
If a cancer has been diagnosed, you might consider adding melatonin, the so-called 'dark hormone', to your anti-cancer regime. This compound (widely available in the USA, but restricted in the UK and in Europe), is an excellent sleep inducer[150]. It has also been shown to stop the growth of breast cancer cells[151, 169], and to have positive effects on established cancers[170] and other proliferative diseases[171].

Melatonin may explain why air stewardesses have twice the normal risk of breast cancer[179]. Each flight increases exposure to ionising radiation (London to New York = four whole body x-rays). And constant moving between time zones disrupts sleep patterns, and inhibits normal melatonin release patterns.

Female air staff and frequent flyers should take anti-oxidants and consider taking melatonin not just to get over jet lag, but also to help reduce the risk of breast cancer.

Lycopene (as with prostate cancer) is also strongly recommended[299, 301, 308-310, 325-330]. Alternatively, lutein may be considered[232], and also Q10[182-184]. Selenium supplements are also clearly indicated. In one good study[234], 200mcg/day of selenium (in selenium enriched yeast) reduced breast cancer by around 50 per cent!

Reducing the risk of cancer



SUMMARY

The anti-cancer good food guide

A preventative strategy

- Low fat, high fibre, largely fruit and vegetable diet, organic if possible.
- Yellow and orange plant foods, dark green leafy vegetables, cabbage, broccoli, tomatoes, peas, onions and leeks, citrus fruits and rosemary.
- Add tomato concentrate and ketchup, preferably low salt.
- Grains (especially oats, wild rice and rye), plus nuts, pulses and fish oil for Vitamin E, PUFAs, phytates, anti-oxidants.
- Soy beans, soy products and/or a daily supplement with 40mg of isoflavones from soy.
- Anti-oxidants C, D, E, K, B group, Q10 and mixed carotenoids (at the levels recommended on page 348).
- Selenium, zinc, manganese and copper to ensure anti-oxidant enzymes are working well (levels on page 348).
- Rosemary and turmeric to upregulate Phase 2 enzymes.
- Pre-biotics and/or live yoghurt.
- Calcium and Vitamin D[175-177].
- Cut down on pickles and cured, grilled and fried meats.

A treatment strategy

- Soy beans and soy products to reduce tumour growth and metastasis.
- Shark cartilage as an alternative angiostat (but see box on page 197).
- Soy (again), lycopene and alpha carotene to induce cancer cells to revert to normal ('re-differentiation').
- Blackcurrants, elderberries and ginkgo as matrix stabilisers.
- Echinacea, Q10 and a broad spectrum vitamin/mineral supplement to boost the immune system (see page 348).
- Turmeric to block tumour necrosis factor alpha.
- Pre-biotics, especially for colon cancer.
- Omega 6 and Omega 3 oils, combined with iron and copper for increased killing of cancer cells (but very controversial).