

**A new type of fibre offers protection against food poisoning, bowel problems, and colon and liver cancer**

**This 'pre-biotic' fibre is found chiefly in vegetables like leeks, onions and oats**

**Fruit and vegetables kept in storage for a long time – like some supermarket produce – lose their pre-biotic value**

**Pre-biotics help 'good' bacteria in the gut to grow – crowding out disease-causing bugs**

**Breast-fed babies have 95 per cent 'good' bacteria – formula-fed have only 25%**

**Formula fed infants and older people have fewer healthy bacteria – but these can be increased with pre-biotics**

**If you're low on pre-biotics, you're vulnerable to all kinds of gastrointestinal problems**

**A healthy gut absorbs calcium and Vitamin K better – reducing the risk of brittle bones**

**A daily dose of pre-biotics could help reduce heart disease and stroke!**

## *Chapter 7*

# Gut reactions – the power of fibre

**E**ver since Dr Kellogg launched his breakfast cereals, a daily intake of dietary fibre has been considered a good thing.

We know that it helps to prevent constipation, haemorrhoids and diverticulosis. We know, too, that some fibres can help to smooth out blood sugar levels in diabetes. And although the experts are still not in complete agreement, there is a reasonable amount of evidence that increasing the fibre in our diet will help to reduce the risk of heart disease, bowel cancer, and possibly even breast cancer.

But there is a problem with fibre which has caused a great deal of confusion and disagreement, among scientists as well as among the public. Until very recently, nobody could agree on what fibre actually was.

It's now generally agreed that there are at least six types of fibre – more according to some experts – which all have different properties, are handled differently in the body, and which all make a different contribution to our health. Some work within the gut; others have important effects elsewhere in the body.

I won't go into all the sub-types of fibre, as it gets rather complicated, but the main point is that, until recently, only two types were used in medicine. These are the insoluble fibres which occur in bran, for example, and which are used to treat constipation. Then there are the soluble fibres in gums such as guar gum, which are used to slow down the absorption of sugar from the gut in diabetics. Both these fibre types are hardly broken down in the gut at all, and pass through the body basically unchanged.

But the emphasis is now switching to another type of fibre that is broken down in the body. This may seem strange, because you probably think of dietary fibre as indigestible – and you'd be correct. These new fibres are resistant to our digestive enzymes, but they are broken down by enzymes produced by bacteria that live in the colon. These fibres are known as non-digestible oligosaccharides, resistant starches or pre-biotics<sup>(19, 47, 136)</sup>.

### A new kind of fibre

The large bowel, which is where the majority of gastrointestinal cancers occur, is full of four to five hundred different species of bacteria, known in medical language as 'flora'. Some of these can cause serious illness, while others are associated with positive health.

Ever since the beginning of this century, doctors have experimented with different diets in an attempt to modify the gastrointestinal flora, and push it in a 'healthy' direction (without much success).

The three recognised types of health-promoting bacteria are the lactobacilli and bifidobacteria<sup>(6-11,42-44,82,83)</sup> found in live yoghurts, and bacillus subtilis, used in Japan to make the fermented soybean dish natto. Both foods have been used to treat gut disorders<sup>(148-150)</sup>.

However, the bacteria ('pro-biotics') have a limited shelf-life, even when freeze-dried, and many of them are unable to survive the acid conditions in the stomach. Even if the bacteria do arrive in the colon, they have to compete with the dense population of hostile bacteria that are already there.

#### Yoghurt

Eating live yoghurt can boost the number of 'good' bacteria in your gut for a while – but pre-biotics are more effective, and the effects last longer<sup>(65, 67)</sup>.

#### **The highest concentrations of pre-biotics are found in:**

- **Chicory root**
- **Jerusalem artichoke**
- **Leeks**
- **Onions**
- **Beans, peas, lentils**
- **Wheat**
- **Oats**

## THE DEFENCE BOOSTERS : Pre-biotic fibre

### Safe

Pre-biotics are very safe. A bowl of French onion soup contains around 6-18g of the pre-biotic inulin. In the name of science, clinicians have injected themselves with ten times this dose of inulin, with no ill effects<sup>(61)</sup>.

Vegetables stored for a long time are low in pre-biotics.

### Antibiotics

Some antibiotics cause problems by killing too many of the gut bacteria.

The French remedy, live yoghurt, is relatively ineffective, but a pre-biotic can help return the gut flora to normal.



### LOOK FOR ...

A daily oligosaccharide supplement of about 6-10g.

There are now commercial sources which can be mixed with orange juice or sprinkled on cereal. It's sweetish and

As long as you eat a daily helping of live yoghurt, some lactobacilli and bifidobacteria remain in the gut, but they disappear almost immediately when the yoghurt diet stops<sup>(65)</sup>.

Pre-biotics have none of these disadvantages. They are stable, safe (they are found in many staple foods), and they have a longer-lasting effect on the gut's flora<sup>(67)</sup>. They encourage the growth of 'healthy' bacteria, which put a check on other bacteria which can cause disease by overgrowth or by producing toxins<sup>(48)</sup>.

We'll consider two of the main types of natural pre-biotic – inulin and oligo-fructose. The general rule is that the fresher the vegetable, the higher its inulin content. When plants such as onions are stored for long periods of time, and particularly in cold or cool storage, their pre-biotic content declines dramatically<sup>(1-3)</sup>.

Because most of us buy our fruit and vegetables from supermarkets where the foods may have been in cold storage for months, this could mean that your pre-biotic intake is actually very low<sup>(116)</sup>.

A low intake of pre-biotics leads to increased numbers of disease-causing bacteria in the gut – which could be the cause of many gastrointestinal and other health complaints<sup>(6-11, 42-44, 82, 83)</sup>.

### WHAT ARE PRE-BIOTICS?

The two main pre-biotics are the non-digestible oligosaccharides (NDOs) inulin and oligo-fructose. These are the plant equivalent of fat – plants accumulate them when there is plenty of solar energy available, and use them as fuel when the skies are dark or overcast.

Inulin and oligo-fructose are both made up of chains of fructose (fruit sugar) molecules, and are related to starch, a more familiar and digestible plant storage compound found in potatoes and cereals.

The richest plant sources of inulin and oligo-fructose are chicory root, which has a long history of medicinal use<sup>(4, 5)</sup>, and Jerusalem artichoke. Because inulin occurs in so many foodstuffs everyone eats some of it – probably around 1-4g in the USA, and 3-11g a day in Europe<sup>(9)</sup>.

A third pre-biotic, beta glucan, is found in oats – and reduces (LDL) cholesterol levels.

A fourth, resistant starch, is formed when carbohydrate foods are repeatedly cooked and cooled.

## How pre-biotics work

Unlike most sugars and starches, pre-biotics cannot be digested and they pass into the colon intact. Once there, they act as a growth enhancer for the health-promoting lactobacilli and bifidobacteria.

As the 'good' bacteria multiply, they secrete enzymes which break down pre-biotics into acids such as acetic and butyric acid. These inhibit the growth of disease-causing bacteria<sup>(31, 52, 53)</sup>. The 'good' bacteria also secrete antibiotic substances which restrain the 'unhealthy' bugs, including most of those responsible for food poisoning<sup>(10, 11, 18, 30, 54-56)</sup>.

As a result, the balance of the flora of the gut tips in a healthy direction<sup>(10, 15-17, 32, 51, 57)</sup>. The flourishing lactobacilli and bifidobacteria in the gut join gastric acid, the digestive enzymes and the immune system in 'crowding' out disease-causing bacteria. You'll benefit from improved intestinal 'regularity'<sup>(66)</sup> and an increased resistance to food poisoning<sup>(62, 64)</sup>.

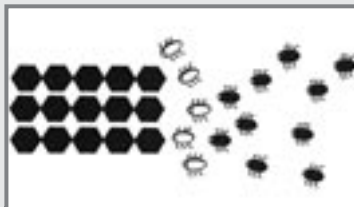
### Stress and stomach upsets

Stress causes a sharp fall in gastrointestinal secretions, and large changes in the colonic flora, including a dramatic reduction in the lactobacilli and bifidobacteria<sup>(139-140)</sup>.

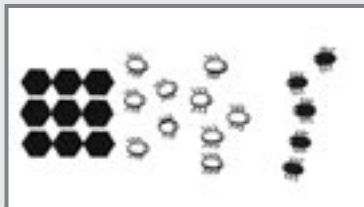
Stress is also an immuno-suppressant; and these two factors explain why stressed individuals are more vulnerable to stomach upsets and food poisoning.

## How pre-biotics tilt the balance in favour of 'good' bacteria

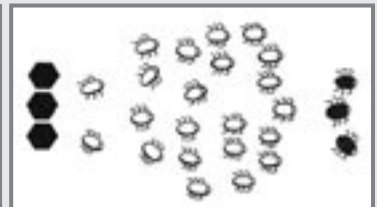
Introducing pre-biotics (shown as hexagonal long chains) provides food for the 'good bugs'.



The harmful bacteria (shown black) cannot digest the pre-biotics



The 'good bugs' (shown white) can digest the pre-biotics and start multiplying



Finally the good bugs crowd out (and kill) the harmful intestinal bacteria

## Babies and pre-biotics

Bifidobacteria are particularly important in the new-born, whose immune defences are not yet fully working. Breast milk contains substances which promote the growth of bifidobacteria, which is why these bacteria represent up to 95 per cent of the bacteria in

## THE DEFENCE BOOSTERS : Pre-biotic fibre

### Breast is best

'Healthy' bacteria make up 95 per cent of the bacteria in a breast-fed baby's intestines – but only 25 per cent in bottle-fed babies.

### Gut feeling

Your body contains about 2kg of bacteria – some good, some bad. When you take a broad-spectrum antibiotic, many of the good bugs are killed too.

Pre-biotics (like resistant starch) help strengthen your defence system by increasing the ratio of good to bad bugs. It's an enhancement strategy not a killer strategy.

### The Right Stuff

The old idea that all dietary fibre was cancer-protective has been demolished and replaced by the more specific concept of protective, pre-biotic fibre.

the gut of breast-fed infants, but a mere 25 per cent in bottle-fed infants. This explains why breast-fed babies are more resistant to stomach upsets and diarrhoea<sup>(59-61)</sup>. Recent studies show that live yoghurt cultures fed to infants significantly reduce their risk of contracting diarrhoea<sup>(84, 112)</sup>; and speed recovery if given as a treatment<sup>(93)</sup>. Indeed, in some areas of the Caucasus, babies are reared, not on milk, but on live yoghurt.

As we age, the proportion of bifidobacteria and lactobacilli gradually falls. This is one reason why we become more prone to gastrointestinal upsets and it is probably also linked to the age-related increase in the risk of bowel cancer<sup>(58)</sup> and other illnesses<sup>(113)</sup>.

## Cancer protection

The cancer story is a complicated one, and many dietary factors (as well as genetic factors) contribute to the overall risk.

There is evidence, however, that bifidobacteria and pre-biotics protect against colon and other cancers<sup>(33-36, 92)</sup>. Bifidobacteria's anti-cancer effects are probably linked to the acids they produce in the gut, which include butyric acid<sup>(46)</sup>. Butyric acid is essential for the health and normal growth of the cells that line the colon<sup>(49, 50, 70)</sup>.

Butyric acid has quite dramatic effects on these colon cells: it slows down abnormal colon cell growth, makes cancer cells less cancerous<sup>(79)</sup> and helps to kill established cancers<sup>(132,133)</sup>. It may be no coincidence that the bacteria that produce butyric acid concentrate in the upper colon, which is relatively immune to cancer<sup>(57)</sup>. But pre-biotics have other anti-cancer effects<sup>(157-163)</sup>.

The risk of colon cancer is increased by a diet high in animal fats – a diet which causes more bile to be secreted. Unhealthy gut bacteria convert bile acids into cancer-causing compounds which increase the risk of liver cancer<sup>(114)</sup>.

Pre-biotics reduce the disease-causing bacteria in the gut, and the amount of cancer-causing compounds they produce<sup>(15, 44, 115, 131)</sup>, which could well have a protective effect.

Finally, as the bifids grow they bind free iron<sup>(134)</sup>, thereby reducing levels of free radicals in the colon<sup>(139)</sup>. This must be another cancer-preventing property.

## COLITIS

In ulcerative colitis, levels of butyric acid are very low in the affected areas of the gut<sup>(101, 102)</sup>. This probably indicates that levels of bifidobacteria are low.

Considering the importance of butyrate to the health of colon cells, it's not surprising that butyric acid infusions improve patients' symptoms<sup>(103, 104)</sup>.

Colitis sufferers can increase their intake of inulin with a small but gradually increasing daily dose of onion soup (or as a supplement). This will increase the numbers of bifidobacteria, and the amount of butyrate these bacteria produce.

## Fibre for the whole body

### Heart

Read the contents' list on a carton of yoghurt and you'll see it contains significant amounts of thiamin, riboflavin and other vitamins. This is because the lactobacilli and bifidobacteria make B vitamins, and are probably the major species of bacteria in the colon which do this<sup>(128)</sup>.

B depletion is surprisingly common in the developed countries<sup>(105-109)</sup>, and low B levels are a major risk factor for coronary artery disease<sup>(110-111)</sup>. So pre-biotics, by increasing the good bacteria in the gut and B vitamin levels, will be cardio-protective by lowering homocysteine, and simultaneously raising HDL levels<sup>(38-42, 68, 71, 72, 76-78)</sup>.

This is one way in which oats and inulin contribute to a healthy heart; although LDL cholesterol reduction also plays a role.

### Short chain = heart + colon health

Short chain pre-biotics (ie fructo-oligosaccharides or FOS) are rapidly fermented, stimulating the production of bifidobacteria (bifidogenesis) in the proximal colon. As they grow they bind the bile acids present in this part of the gut and remove them from the body<sup>(121)</sup>. This lowers LDL cholesterol levels<sup>(19,26-29, 37,42-44,82,83, 99,113,121-123)</sup> and confers additional cardio-protection. The combination of bifidogenesis and bile acid binding is also likely to be cancer protective<sup>(141-143)</sup>, especially if FOS is combined with longer chain pre-biotics.

### Which pre-biotic?

Resistant starches are probably the best cancer-protective pre-biotic for functional foods. They ferment slowly, producing high levels of butyrate in the lower colon; and critically, from the point of view of social acceptance, relatively little hydrogen.

### Butyric acid

Butyric acid speeds healing after intestinal surgery<sup>(79)</sup>.

### Pre-biotics and breast cancer

Pre-biotics may help to prevent cancer elsewhere in the body<sup>(115)</sup>. They reduce the incidence of mammary cancer in rats<sup>(82)</sup> by altering the way in which oestrogen is metabolised by bacteria in the bowel.

## THE DEFENCE BOOSTERS : **Pre-biotic fibre**

### **Five more good things about pre-biotics**

- **They encourage bifidobacteria to grow, producing acids which smooth out blood sugar levels**
- **These acids may discourage the body from laying down fat<sup>(12-14, 25)</sup>**
- **Oligofructose is a low calorie sweetener – at 1.25 calories per gram it's less than a third of sugar<sup>(20)</sup>**
- **Oligofructose and inulin cause less tooth decay than sugar, and are safe for diabetics**
- **Pre-biotics may stimulate the immune system, either directly or via the bifidobacteria<sup>(137)</sup>**

### **Long chain = colon health**

Longer chain pre-biotics (inulin, resistant starches) are slowly fermented, stimulating bifidogenesis further down the gut in the lower colon and rectum. This is the main site of bowel cancer, and bifidogenesis here (with the resulting local production of butyric acid, etc) confers significant protection against this type of tumour.

### **Bones**

Bacillus subtilis produces Vitamin K2<sup>(149-150)</sup> – essential for healthy bones and arteries (see Chapters 14, Heart Disease and 15, Bones). K2 is not taken up in the colon<sup>(145-147, 151)</sup>; **unless** pre-biotic fibres are present, producing butyrate in which K2 is absorbed. The age-related decline in lactobacilli and bifids in the gut helps to explain why K deficiency – and hence osteoporosis – is so common in the elderly<sup>(152-155)</sup>. The fact that these bacteria normally aid the absorption of calcium and magnesium leaves the elderly even more exposed<sup>(21-24, 69)</sup>. A pre-biotic supplement designed to boost the uptake of these minerals and Vitamin K should therefore be highly bone-protective.

Contrary to previous medical opinion, calcium is now known to be absorbed in the colon. One of the reasons why calcium in milk is better absorbed than from chalk-type supplements is because milk contains substances which promote bifidobacteria, which in turn boost the absorption of the calcium in the colon.

### **Vaginal and urinary tract infections**

Bifidobacteria are an important part of the normal bacterial population of the vagina. The acids and antibiotics they produce make it hard for other micro-organisms to thrive<sup>(117-119)</sup>. When the balance of bacteria in the vagina is disturbed, thrush, bacterial vaginosis or urinary tract infections can follow.

Live yoghurt, which can contain either bifidobacteria or lactobacilli, has traditionally been used as a treatment for thrush, but it is messy and not very effective. More scientifically, pessaries containing lactobacilli have been shown to reduce urinary tract infections by as much as 80 per cent<sup>(120)</sup>. An oligofructose pessary, which would encourage the growth of lactobacilli, is a simpler solution, and could be used both as a

treatment and as a preventative measure for women prone to bouts of candida, bacterial vaginosis or UTI.

It may also have some protective effect against sexually transmitted diseases such as chlamydia, gonorrhoea, syphilis, and even HIV<sup>(118)</sup>.

### Teeth and gums

There is evidence from a Finnish lab that oligosaccharides can help protect your teeth. After eating live yoghurt, the population of bifidobacteria in the mouth increases, and remains high for a few days<sup>(98)</sup>.

This almost certainly helps to crowd out the other species of bacteria which cause dental decay and gum disease. So buffered pastilles containing oligosaccharide may help to keep your teeth and gums intact (see also Chapter 9, Q10 and L-carnitine).

The mouth is an important reservoir of potentially disease-causing bacteria, many of which are resistant to antibiotics. A pre-biotic-loaded chewing gum is therefore an interesting approach not just to tooth decay but also to other infections. For example, the bacterium which causes peptic ulcers, helicobacter pylori, lives in the mouth. Oligofructose pastilles or gum could keep it in check,<sup>(100,127)</sup> and reduce the risk of peptic ulcers in high risk groups such as smokers.

Many bacteriologists believe that oral bacteria can escape from the mouth to cause infection after operations, meningitis, upper respiratory tract infections and septicaemias<sup>(125)</sup>. By reducing the disease-causing bacteria in the mouth, pre-biotic pastilles should protect against these infections. They should also contain buffers and xylitol to minimise dental decay<sup>(138)</sup>.

#### LIVE YOGHURT

Early this century, the great Russian scientist, Eli Metchnikoff, published his theory that eating live yoghurt was the way to achieving long life.

Although this idea was based on keen observation, his views were dismissed by the establishment because Metchnikoff could not explain how his theory might work. Now we can see a plausible way in which eating live yoghurt could reduce the risk of a number of serious disease conditions, his theory no longer seems quite so absurd.

### **Should I take a pre-biotic supplement?**

**Yes, if you are:**

- **Prone to stomach upsets**
- **Travelling to an area where gastrointestinal illness is common<sup>(94-97)</sup>**
- **Suffer from gastroenteritis, Crohn's Disease or ulcerative colitis<sup>(75)</sup>. Combine pre-biotics with amino sugars and/or glutamine**
- **Taking antibiotics. Pre-biotics may reduce the diarrhoea often caused by antibiotics and help to re-establish a healthy gut<sup>(85)</sup>**
- **Prone to attacks of thrush or bacterial vaginosis. A pre-biotic pessary will encourage the growth of healthy bacteria in the vagina and crowd out the nastier types of micro-organisms**



### Indigestible fibres are anti-oxidants

Indigestible fibres contribute significantly to the total anti-oxidant capacity of our diet<sup>(144)</sup>.

High fibre cereals and wholegrain wheat, oats and bread are good sources; white flour goods are not (see page 357).

### Old-fashioned fibre

We shouldn't forget the more familiar insoluble dietary fibres such as bran, which pass through the entire gut unchanged, and used to be called roughage. Here too, the scientists have uncovered a possible anti-cancer effect – and again, the bacteria that live in the gut play an important role.

Even so-called indigestible fibre is broken down, to some extent, by bacterial enzymes. Part of the fibre is broken down to release compounds which have considerable anti-oxidant properties<sup>(86-88)</sup>. These are thought to scavenge dangerous radicals, which have been linked to gastrointestinal and other cancers<sup>(89-91)</sup>.

So while the recently discovered soluble fibres are important, a regular intake of the old-fashioned kind of roughage is a good idea as well for anyone concerned with staying healthier, for longer.

### STAY POPULAR!



In some people pre-biotics can cause flatulence and, if very large amounts are taken, diarrhoea.

In this respect, inulin is less likely to cause problems than oligofructose. If you react badly to onion soup or vichyssoise (made of leeks), which both contain large amounts of inulin, you can probably still take pre-biotics – but start with small doses. Any initial problems generally soon subside, once the new colonic regime becomes established. Resistant starches are the least likely to cause problems.

## Processed food problems

- 1 Many processed foods contain sulphate and sulphide preservatives.
- 2 Recent research has shown that certain 'hostile' bacteria in the gut turn sulphur compounds to hydrogen sulphide, which is toxic, and linked to colitis and irritable bowel syndrome.
- 3 Not everyone has these hostile bacteria but in those that do, sulphur compounds in the diet stimulate the growth of these bacteria, which produce more hydrogen sulphide and increase the symptoms<sup>(124)</sup>.
- 4 Hydrogen sulphide is a carcinogen. It also appears to block the production of butyrate – the acid which promotes healthy cells in the colon – and so could be a substantial cancer risk. This is another reason to cut down on badly formulated processed foods.
- 5 **Don't** cut down on foods which naturally contain sulphur compounds (brassica, such as cabbage, broccoli and Brussels sprouts). These vegetables contain many health-enhancing compounds and are protective against cancer.

## **SUMMARY**

### **Fibre providers**

- Include pre-biotic rich foods like Jerusalem artichokes, leeks, onions, legumes and pulses in your diet.
- Make sure your fruits and vegetables are as fresh as possible.
- Alternatively, take daily a pre-biotic supplement. Ideally combine a small dose of a rapid-acting short chain pre-biotic (ie FOS) with larger doses of a slower-acting pre-biotic (ie resistant starch). You could combine these with a proven pro-biotic such as LC1 from Nestlé to create a 'symbiotic'.
- The combination of a pre-biotic and a pro-biotic is known as a 'symbiotic'.
- Maintain your intake of roughage, ie bran products, fruit or vegetables.
- Anyone with rheumatoid arthritis or other auto-immune conditions should use pre-biotics with caution.
- Where possible, babies should be breast-fed to protect them against stomach upsets.
- Formula milk should be fortified with a pre-biotic to make it more like breast milk – as is now done in Japan.
- Infants with stomach upsets can be given live yoghurt.