

patrick
HOLFORD

and Dr James Braly

Optimum Living Made Easy

THE
HOMOCYSTEINE
SOLUTION

THE FAST
NEW WAY TO
DRAMATICALLY
IMPROVE
YOUR HEALTH



BODY

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Introduction

STAYING HEALTHY, HAPPY, clear-headed and full of energy into old age – this is what we all want. But ensuring that we do depends on how well we can ‘read’ the state of our health. What if there was a single test that could do that, as well as pointing the way forward to a superhealthy future? This book is about an extraordinary discovery that has taken the world of medicine by storm. Open almost any medical journal today and you’ll find something about homocysteine, a substance with a remarkable trait. Like a chemical crystal ball, it reveals exactly what we should be doing to guarantee our future health. This amazing predictive chemical is an amino acid – a building block of protein – found naturally in the blood. Our levels of it, or our ‘H score’, are more accurate than a cholesterol reading in terms of predicting our risk of a heart attack or stroke, and a better measure than genes of our risk of Alzheimer’s.

In fact, your H score predicts your risk of over 50 diseases – including increased risk of premature death from all common causes. It can even tell you how quickly you will age. And by revealing your B vitamin nutritional status, immune system function and the state of your brain, it shows how well your body’s chemistry can roll with the punches. If this was the whole story, many of us would rather not know. But a high H score is anything but cause for gloom. The reason? It’s remarkably easy to fix. In a mere two months you can ensure your future health, potentially halving your risk of most life-threatening diseases and even slowing down the ageing process. We know how, and we want you to know. You might already be taking some steps in the right direction.

Maybe you’ve quit smoking, lost some weight, lowered your cholesterol, or are taking a high-quality daily multivitamin. But how do you really know where you stand on the scale of health and disease? If you don’t know your H score, you won’t ever really know. What you will discover in this book is that most people’s H scores, which can now be tested at home using a simple kit, are around 11 points. Probably two in ten people reading this book will have a superhealthy H score below 6, and two in ten will have an extremely unhealthy H score above 15. But what does this mean? Researchers from the University of Bergen in Norway, one of the world’s leading homocysteine research centres, measured the homocysteine levels of 4,766 people in their sixties a decade ago, and then recorded who died and who didn’t. This is what they discovered.

A mere five-point decrease in H score predicted a:

- 49% reduced risk of death from all causes
- 50% reduced risk of death from cardiovascular disease
- 26% reduced risk of death from cancer
- 104% reduced risk of death from any causes other than cancer or heart disease.

These are pretty staggering statistics, and you’ll find them confirmed again and again by researchers all over the world. But let’s look at what this means in real terms. Let’s say you’re average, with an H score of 11 points. By following the advice in Parts 4 and 5 of this book – what we call our H Factor programme – your H score should drop about five points in two months. And your risk of getting over 50 diseases will also substantially decrease. If your H score is 16 and you follow the H Factor programme for four months, you’ll decrease your score by up to ten points and end up with a fraction of the risk you started with. And we’re not just talking about adding years to your life. We’re also looking at how to add life to your years. Whether you are young or old, sick or healthy, the best time to measure your H score is now. Then, if necessary, you can do what you need to do to bring it into the healthy range. If you’re young, remember that homocysteine does much more than predict risk for diseases – it also shows how well we’ll cope with life’s long rollercoaster ride.

Case study: Alan is a case in point. His father died of heart disease at the age of 56, so not surprisingly, being 56, he was concerned about the history of heart disease in his family. Alan also used to be very active but as he got older he did less exercise – and then he’d have a glass of

wine, or two, a night. So he thought he'd get a checkover. His cholesterol was normal, as was his blood pressure. His homocysteine, however, was 14.6, putting him in the high risk category. He started supplementing B6, B12 and folic acid. Within three months his homocysteine level was 9.6, reducing his risk of a heart attack by more than a third.

Homocysteine measures your body's age and intelligence

It's an incredible fact that not only are we literally made from the food we eat, but that 70 per cent of our bodies are also renewed every year. The 'you' that stares back from the bathroom mirror isn't the same 'you' that stared back a year ago! It is, quite literally, a miracle. So, what is the 'intelligence' in our make-up that keeps making us new, or nearly new, every year? It's all down to two extraordinary chemical balancing acts in the body. One is called methylation. The other is oxidation-reduction. If you can get these two working at peak levels you are going to feel great, and stay vibrantly young – mentally, emotionally and physically. Both are measured and predicted by your blood levels of homocysteine and both can be improved by the right nutrients, gleaned from both diet and supplements. And this is a vital step. Methylation and oxidation-reduction largely control how rapidly you age and how early chronic disease sets in. If you lack antioxidants in your diet, such as vitamins A, C, E and selenium, you age more quickly and get sick sooner.

The same happens if you lack 'methylating agents' in your diet, such as vitamin B12 and folic acid. These two chemical processes have got a lot more to do with your lifespan and pattern of diseases than your genes. In fact, even gene 'mutations' that increase the risk of disease can be controlled by methylation. According to Dr Adrian Bird of Edinburgh University, 'One in three mutations that cause human disease can be attributed to methyl groups on our genes.' Homocysteine reflects the health of your genes, how well you are holding back the clock and your risk of premature death from all common causes. That's how all-encompassing the homocysteine story is. Your H score is more important than your weight, your blood pressure or your cholesterol level. Quite simply, it is your most vital, preventable and reversible health statistic.

Lowering homocysteine is easy with the H Factor programme

So, let's say your H score is higher than you'd like. What can you do over the next two months? All the H Factor programme involves are some simple changes to your diet, and a daily homocysteine-busting supplement or two. For a few pence extra a day, you can progress from potential health risk to maximising your health potential. Using homocysteine as our yardstick, we've been researching exactly what kind of diet, supplement and lifestyle put you in the 'superhealth' category. We've looked at meat versus vegetables, wine versus beer, the effects of coffee, smoking, salt, being overweight and many other potentially harmful or protective foods, drinks and habits. And there are some surprises in store. As you might expect, excess alcohol and cigarettes are extremely bad news. But do you have to quit completely? Yes, for smoking.

No, for alcohol. In fact, small amounts of alcohol may even be beneficial. Smokers, on the other hand, have high H scores which plummet on stopping, but barely change on cutting back. Strict vegetarians are more likely to have a high H score than meat eaters. We'll explain why. Going on a weight-loss diet increases, rather than decreases, H scores. This doesn't mean you shouldn't diet, but does mean you definitely shouldn't go on one without taking homocysteine-lowering supplements. Speaking of supplements, the evidence is clear. Certain vitamin supplements lower your H score much more effectively than diet changes alone. We advocate both supplements and dietary change and will tell you exactly what to take depending on your H score. As you will see, the right combination of four B vitamins, zinc and a nutrient you might never have heard of – trimethylglycine (TMG) – can lower homocysteine in a matter of weeks.

There are other beneficial supplements, too. The medical profession has homed in on folic acid as the 'answer' and, both in Britain and the US, folic acid supplements are starting to be more widely recommended, both by doctors and by government health advisers. However, folic acid on its own

often can't lower a high H level down to within a safe range. The right combination of nutrients, on the other hand, works almost every time. Interestingly, there's no drug yet discovered that lowers your H level, which is probably why the medical profession, used to massive campaigns to launch new drugs, has been slow to embrace this vital breakthrough. With no drug, there's no great profit to be made. In fact, exactly the opposite. If you do what we recommend in this book, you could bankrupt a few of the pharmaceutical companies who are selling drugs that treat only symptoms of disease, while promoting companies and therapies that treat underlying causes of diseases with the right diet, lifestyle and supplements. We've put all this together into an easy, economical plan. All you do is measure your H score to know exactly where you are right now, then follow the recommendations in Parts 4 and 5, retest and see your H score fall. Once you hit the superhealthy goal – an H score below 6 – you've programmed yourself for super-health.

About this book

One last note before we plunge in to the particulars. We have made some bold claims here and in the rest of the book we'll show you how everything we say is backed up with good science – lots of it!

Part 1 explains what homocysteine is, why it's so bad when elevated, how lowering it decreases your risk of having the top five killer diseases, and how widespread the homocysteine problem is the world over.

Part 2 explains the risk factors for high homocysteine, and how you can test your own H level and see where you are on the scale from health to disease.

Part 3 gives you detailed information on some of the 50 medical conditions now linked to high homocysteine. If you suffer from any of these diseases, we want you to know the whole story.

Part 4 gives you the *raison d'être* of the H Factor programme. And it shows you why too much meat or extreme vegetarian diets can be bad news, why a little (but not too much) alcohol may help, and why caffeine, smoking and stress all raise homocysteine – and what you can do about it.

Part 5 explains why certain supplements can lower high homocysteine levels and which combinations and doses work best, depending on your H score.

Ten steps to superhealth puts it all together into a simple ten-step action plan to bring your homocysteine level into the superhealthy zone.

Wishing you the best of health, Patrick Holford and Dr James Braly

PART 1 The Homocysteine Story

Chapter 1: The health secret of homocysteine

WE OWE A LOT, and very possibly our lives, to one smart, courageous man – Dr Kilmer McCully. His discovery that homocysteine is probably your single most vital health statistic, and his tenacity in proving it despite immense resistance, has led to a revolutionary breakthrough in medicine. As this book unfolds, you will see how the discovery of homocysteine has revealed the cause of heart disease, strokes, cancer, diabetes, Alzheimer's and over 50 other common diseases, and, most importantly, how this knowledge can help you to prevent yourself from ever getting them. But let's begin at the beginning. Way back in 1968 McCully, who trained at Harvard Medical School, was studying children with a rare genetic disorder called 'homocystinuria'. Children born with this condition lack certain enzymes required to turn a naturally occurring yet potentially toxic substance, homocysteine, into a harmless substance called cystathionine.

As a consequence, they have extraordinarily high levels of homocysteine in their blood, well above 100 units. To give you some idea of how serious this is, even a score above 9 is now considered high risk. Unless they are diagnosed and treated, these children often die at a very young age of heart attacks and strokes, once thought to be caused in large part by high cholesterol, despite having completely normal cholesterol levels. One infant died at the age of two months from advanced arteriosclerosis. And sufferers often have a variety of other ailments. When he was reviewing these cases, McCully came to realise that homocysteine, rather than cholesterol, might be a fundamental independent risk factor of arteriosclerosis and atherosclerosis, and therefore of heart attacks and strokes. And he went on to prove that it is.

But the medical profession wasn't ready to listen. McCully was dismissed from Harvard and shuffled from job to job, insistent on continuing this 'unpopular' line of research, which was then sidelined in cardiovascular medicine until the 1990s. Over the past decade, thanks to McCully's hard work and tenacity, evidence for the homocysteine theory has piled up. Now, finally, mainstream medicine is sitting up and taking note.¹ The initial research focused on the relationship of homocysteine to cardiovascular and cerebrovascular disease – heart attacks, strokes and artery disease. In 1992 a study of 14,000 male doctors found that those with homocysteine levels in the top 5 per cent had three times the risk of having a heart attack, compared to those in the bottom 5 per cent.

This increased risk was confirmed in 1995 by the internationally acclaimed Massachusetts-based Framingham Heart Study, which found that having more than 11.4 micromoles of homocysteine per litre of blood (a measurement we call 'units') increased the risk significantly.² Another study at the University of Washington found that having a high H score doubled the risk of heart attack even in young women. The real clincher was a study carried out by the European Concerted Action Group, a consortium of doctors and researchers from 19 medical centres in nine European countries.³ They studied 750 people under the age of 60 with blockages in their coronary arteries, and compared them to 800 people without cardiovascular disease.

They found that having a high H score was as great a risk factor for cardiovascular disease as smoking or having a high blood cholesterol level. Those whose homocysteine levels were in the top fifth doubled the risk of cardiovascular disease. Most significantly, the group also found that those taking vitamin supplements had a risk factor two-thirds less than those not taking them. That's because certain supplements lower your H score and your risk. Today, totally vindicated, Dr McCully is a best-selling author and pathologist at the Veterans Affairs Medical Center in Providence, Rhode Island. And in conventional cardiology, the branch of medicine that deals with heart disease, homocysteine is rapidly being recognised as a significant independent cause of risk, on a par with cholesterol. (Later on we will show you why high homocysteine is in fact a far greater risk factor for heart disease than cholesterol). However, this link to heart disease is just the tip of the iceberg: the discovery of homocysteine has identified a fundamental cause and biological indicator, or marker, of all ageing, in every single one of us.

Reduce your risk of the top five killer diseases

At least one in two people now die prematurely from preventable diseases, and over one in two have high homocysteine levels. Huge numbers of us tend to adopt the ostrich technique, and bury our heads in the sand, letting all that sensible health advice wash over us – until it's too late. Our clinics are full of people who've had a heart attack or stroke, or whose mental gears are slipping into a state of senility, or who have been diagnosed with cancer or diabetes. It's only then that, out of desperation, they become willing to listen to medical advice. It doesn't have to be this way. There is a way to age slowly and gracefully, physically vital and mentally sharp to the very end of a long and healthy life. It's prevention – always much simpler and more pleasant than cure. Remember, the top five killer diseases – heart attacks, strokes, cancer, the complications of diabetes and Alzheimer's – are mostly preventable. The trick is to start your disease prevention strategy BEFORE you have the disease.

How? One of the best places to begin is to find out your H score. If your homocysteine levels are too high, you can bring them down to safe levels with our simple H Factor programme. Once you've done that, you've effectively insured yourself for a healthy future. You'll find out all about this in Parts 4 and 5. But knowing your H score doesn't only give you an indicator of what measures you need to take to protect yourself from many diseases. It's also a clear indicator of your ability to fight infections, your mental and physical energy and how quickly you are ageing.

Extending your healthy lifespan

Once you hit 65, statistics say you'll live another 16 years, if you're a man, and 18 years, if you're a woman. Amazingly, this hasn't changed much over the decades. Back in the 1930s, once you reached 65 you'd have a life expectancy of only three years less than the contemporary figure.⁴ So modern medicine has only added three more years of life! According to the American Academy of Anti-Aging Medicine, this is still a long way short of our true potential as human beings, which they believe is living to the maximum lifespan of 120, free of degenerative disease. As Figure 1 (below) shows, the ideal health objective is to flatten the lifespan curve, so you live fully, with all your senses intact, free of pain and disabling fatigue, until you die. For most of us, realistically, that point should be around 100 years old, at least. This is what is predicted for those who have followed the practice of 'optimum nutrition' and a healthy lifestyle all their lives. If you've only started behaving yourself in your forties or fifties, your maximum lifespan may be in the nineties. But we are not talking about adding years of decrepitude. We are talking about having the energy, memory and physical function of a 50-year-old when you are 70, and of a 60-year-old when you're 90.

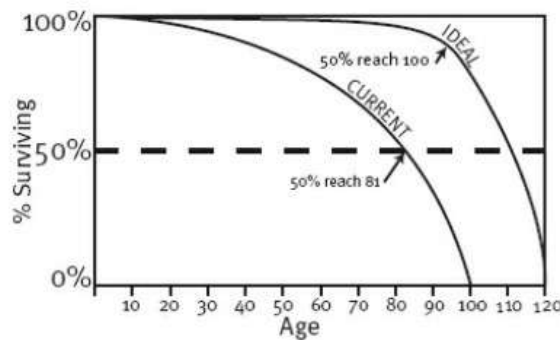


Figure 1. Extending your healthy lifespan

How can this be done?. One of the best ways to extend your healthy lifespan is by reducing your homocysteine level with the H Factor programme. With every five-point decrease in your H score, you will gain:

- A 49% reduced risk of death from all causes
- A 50% reduced risk of cardiovascular death (such as heart attacks and sudden death)
- A 26% reduced risk of death from cancer
- A 104% reduced risk of death from any causes other than cancer or heart disease.

These are the extraordinary findings from a comprehensive research study at the University of Bergen in Norway, published in 2001 in the American Journal of Clinical Nutrition.⁵ They measured the homocysteine levels of 4,766 men and women aged 65 to 67 back in 1992, and then recorded any deaths over the next five years, during which 162 men and 97 women died. They then looked at the risk of death in relation to their homocysteine levels. Remarkably, they not only reconfirmed the relationship between heart attacks, strokes and high levels of homocysteine, but also found that 'a strong relation was found between homocysteine and all causes of mortality'. In other words, your level of homocysteine is an accurate predictor of how long you are going to live, whatever the eventual cause of death may be! If you are already in your fifties or sixties, you might be tempted to view this news with gloom. But with a guaranteed way out – the H Factor programme – the news is all good, because you can begin to do something about it right

now. Now, let's take a look at more encouraging news that shows how homocysteine predicts each of the top five killer diseases. Why is this encouraging? Because it means you can dramatically reduce your risk of ever dying from any one of these by lowering your homocysteine level.

Heart attacks – reduce your risk by 80%

Elevated homocysteine causes at least 56,000 deaths in the US each year. Other medical experts now strongly feel that 12 per cent of all deaths can be attributed to high homocysteine; in the US that would amount to 240,000 deaths a year. By some estimates, 30 to 40 per cent or more of all heart attacks or strokes may be the result of elevated homocysteine. That's the bad news. The good news is that by following our plan, you can reduce your risk by up to 80 per cent.

Case study: Ian, aged 56, started getting excessively tired and breathless, with frequent pounding headaches and eye pressure. He was diagnosed with high blood pressure, of around 180/120 and put on two blood pressure lowering drugs, bendroflurozide, irbecartan, which have helped, together with some diet and lifestyle changes, to lower his blood pressure to 140/75. He drinks less coffee and has reduced the stress in his life, which was considerable as a journalist. When he had his homocysteine level checked he scored a massive 42.8, putting him in the very high risk category. After following the H Factor diet and supplement programme, initially taking 6 homocysteine lowering supplements a day, Ian re-tested after two months and was amazed to see his score had dropped by 80%, to 8.2. His blood pressure had dropped enormously to a completely normal 124/177. Ian has now reduced his supplements to 2 a day and reports that he has more energy, is more even-tempered and is not as stressed as he used to be. 'I certainly feel a good deal better and am very pleased by this'.

Strokes – cut your risk by 82%

Strokes are the third biggest killer after heart attacks and cancer, and often leave survivors seriously disabled. Yet the fact is that your homocysteine level predicts your risk of a stroke even better than it predicts your risk of a heart attack – and it does so better than any other single measure, including your cholesterol level, blood pressure or whether or not you smoke. The upside is that knowing and reducing your H score can cut your risk by up to 82 per cent.

Cancer – cut your risk by a third

Cancer is largely preventable. The World Cancer Research Fund estimates that by eating the right diet you can cut your risk of cancer by up to 40 per cent. The European Commission estimates that a quarter of a million lives could be saved each year across the 12 member states through dietary changes alone. You can further cut your risk by eating organic whenever possible, exercising regularly, adding vitamin and mineral supplements and avoiding known carcinogens – such as smoking, oestrogen replacement therapy (HRT), and eating excessive animal fats and overcooked or blackened meats. We estimate that cancer is about 85 per cent preventable. Research published in the New England Journal of Medicine describing a study involving 45,000 pairs of twins found that cancer is more likely to be caused by diet and lifestyle choices than by genes. Identical twins, who are genetically the same, had no more than a 15 per cent chance of developing the same cancer. This suggests that the cause of most cancers is about 85 per cent environmental – that is, down to factors such as diet, lifestyle and exposure to toxic chemicals.

This study found that choices about diet, smoking and exercise accounted for 58 to 82 per cent of cancers studied.⁶ So where does homocysteine come into all this? Cancer is triggered in large part by damage to DNA – and having a high homocysteine level means your DNA is more vulnerable to damage, and poorly repaired once damaged. At the other end of the scale, a high level of homocysteine has been found to be a very good indicator of whether cancer therapies are working. The homocysteine level rises when tumours grow, and falls when they shrink. Forms of cancer already clearly linked to high homo cysteine include cancer of the breast and colon, and

leukaemia, among others. Low homocysteine is likely to reduce your risk of these by a third. Coupled with other diet and supplement changes, you should be able to cut your cancer risk by more than half.

Diabetes – lower your risk

Type II, or adult-onset, diabetes is highly preventable. Yet more and more young people are developing it. The obesity ‘epidemic’ in the West has helped fuel this rise. If you are obese, the risk of developing diabetes goes up 77 times! Why? Because too little exercise, not enough fresh fruits and vegetables, too many refined carbohydrates (white bread, cakes, biscuits, sugar, etc.) and the added stress on your body all make your blood sugar control go out of balance. When blood sugar levels rise too high, the body produces insulin to help bring the level down. The more often you have these high levels of glucose (that is, high blood sugar), followed by insulin production, the more ‘deaf’ or resistant your body cells become to insulin. Insulin resistance is now found in a quarter of all people in the industrialised world, and in over 90 per cent of obese people. Since insulin lowers blood sugar, the net result of insulin resistance is too much sugar in the blood – in other words, diabetes. Diabetics are at risk of having high homocysteine because we now know that the abnormally raised insulin seen in most diabetics stops the body from lowering and maintaining a healthier homocysteine level. By following the H Factor programme, you will be able to help to reduce your risk of diabetes or, if you are diabetic, you’ll be able to help keep it under better control and reduce complications.

Alzheimer’s – halve your risk

The evidence indicates that if you can lower your H score, you will significantly lower your risk of getting Alzheimer’s. Homocysteine is strongly linked to damage in the brain. Dr Matsu Toshifumi and colleagues at Tohoku University, Japan, conducted brain scans on 153 elderly people and checked them against each individual’s homocysteine level. The evidence was crystal clear – the higher the homocysteine, the greater the damage to the brain.⁷ A recent study in the New England Journal of Medicine charted the health of 1,092 elderly people without dementia, measuring their homocysteine levels. Within the next eight years, 111 were diagnosed with dementia. Eighty-three of this group were diagnosed with Alzheimer’s. Those with high blood homocysteine levels (in this study, above 14 units) had nearly double the risk of Alzheimer’s. All this strongly suggests that following the programme outlined in Parts 4 and 5 of this book should, at the very least, halve your risk of developing Alzheimer’s in later years.⁸ The chances are excellent that the H Factor programme will eliminate your risk completely. And the upshot of all this? The connection between homocysteine and the ‘big five’ killer diseases indicates that if you can lower and maintain your H score into the superhealthy range, defined as under 6 units – and you can with the H Factor programme – you are likely to add at least ten or more quality years to your life.

Chapter 2: What is homocysteine?

WE NOW KNOW that homocysteine is an extremely important marker for health and disease. But there’s much more to tell. This chapter is a full-length portrait, if you like, of this vital amino acid.

Methyl magic: Homocysteine is made in the body from another amino acid, methionine. As meat, cheese and some other proteins are especially rich in methionine, we tend to eat this amino acid every day. Why does the body make homocysteine and what does a high level tell us? It’s all to do with a fundamental process upon which your life depends. We first encountered it in the introduction to this book. It’s called methylation. To understand methylation we need to know a bit about body chemistry. You eat 10 tons of food in your lifetime and, somehow, this turns into you. Your body is quite literally a sea of chemicals, a hairy bag of salty soup concocted out of millions of them, from glucose to fats, and amino acids to hormones and neurotransmitters. For example, when you are under stress, the body makes more adrenalin to keep you going. When you go to bed, the body releases melatonin to help you sleep. When you’ve got a cold or flu the body makes more glutathione, which turns your immune cells into cold-busting warriors.

These are just three examples of literally hundreds of thousands of adjustments the body makes every second to keep you healthy and alive. But how on earth does the body keep everything in balance? This is where methylation comes in. In the methylation process ‘methyl groups’, which are made of one carbon and three hydrogen atoms, are added to, or subtracted from, other molecules. This is how the body actually makes the substances it needs, or breaks down those it doesn’t – by transforming one biochemical into another. Methylation happens over a billion times a second. It is like one big dance, with biochemicals passing methyl groups from one partner to another. Take noradrenalin. The brain produces this chemical to keep you happy and motivated. However, if you are under stress, it adds a methyl group to noradrenalin in the adrenal glands to make adrenalin, which gives you a burst of energy and aggression known as the ‘fight or flight syndrome’. This is how homocysteine is made in the body. When you eat a piece of fish containing methionine, it’s incorporated into your bloodstream and inside your cells and a methyl group is taken away from the methionine, leaving you with homocysteine.

Ideally, the body adds a different methyl group back to homocysteine to convert it into an extraordinarily important chemical called S-adenosyl methionine (SAME, pronounced ‘Sammy’, for short). SAME is a natural anti-depressant, anti-arthritic and liver-protecting agent in your body. It also becomes a methyl donor in its own right, readily giving up its methyl group to help alter other body chemicals. Homocysteine can also be converted to another extremely important body chemical, glutathione. Glutathione is the body’s best anti-ageing antioxidant and detoxifying agent. A low glutathione level is, like a high homocysteine level, linked to increased risk of death from all common causes. So methylation is also the key to slowing the ageing process and keeping your body free of toxic chemicals. It is also thought that methylation plays a critical role in protecting us from certain serious diseases. Methyl groups are added to and subtracted from our DNA. When not enough methylation is going on, our DNA cannot properly repair itself, which puts us at higher risk from cancer and autoimmune diseases such as rheumatoid arthritis or lupus.

What’s your methyl IQ?

It can be helpful to think of people with high-functioning methylation as having a high methyl IQ. They stay in balance, while those with a low methyl IQ suffer from chemical imbalances that ricochet into almost every organ and tissue of the body. The best, most sensitive methyl IQ test is your homocysteine level. When your H score is low (below 6 units), you are well methylated, your SAME and glutathione levels are most likely high, and you are in good health. When your H score is too high, you suffer from a methyl deficiency, and not surprisingly a deficiency in SAME, glutathione and lots of other vital bio-chemicals. This relationship between homocysteine, methylation and vital body chemicals is complex but vital (see Figure 2 below). Provided your body has a good methyl IQ, only small amounts of homocysteine accumulate, with the great majority immediately methylated, en route for greater destinies.

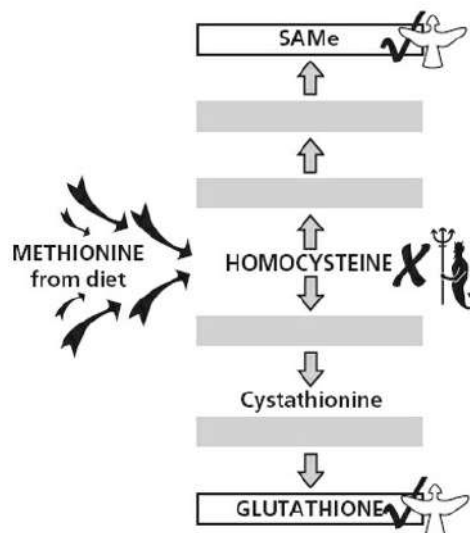


Figure 2. The main players in the homocysteine pathway

(For the more technically minded, turn to Appendix 1, page 236, for an unabridged version of the homocysteine pathway). We've had a taster on how the body deals with homocysteine. Now let's look closer. Normally, as soon as methionine is converted to homocysteine, the body then changes it as quickly as possible in one of two ways:

- It adds sulphur with an enzyme called cystathionine betasynthase, which turns homocysteine into something called cystathionine. From there, with the help of another enzyme called cystanthionine lyase, it's converted into glutathione, the benefits of which we've seen above.

- With the help of key B vitamins and zinc, the brain adds back a methyl group to homocysteine in a process called remethylation. Two enzymes are essential to this process. The first is called homocysteine methyltransferase and the second methylenetetrahydrofolate reductase – impossible to remember, so it's abbreviated to MTHFR. Homocysteine methyltransferase adds a methyl group to homocysteine, then MTHFR helps turn it into SAME. (You'll be hearing more about the MTHFR enzyme later because about one in ten people have a genetic mutation that means this enzyme doesn't work so well, and so these people are much more prone to high homocysteine and have to work a bit harder to reduce it). In Figure 2 above, you can see how homocysteine can convert to either SAME or glutathione.

If this conversion process isn't working well – for example, due to a lack of the co-factors (vitamins and nutrients) which the homocysteine-converting enzymes need to function – homocysteine begins to accumulate in the body, and that spells trouble. Increased levels of homocysteine and therefore decreased levels of methylation, SAME, glutathione and B vitamins are associated with chronic symptoms many of us experience every day. We'll be looking at these in Chapter 6, which will also tell you how to assess your level of homocysteine. What if you feel good, though? Don't make the fatal mistake of assuming that if you don't have the symptoms, you don't have a problem with homocysteine. High homocysteine, especially in the early stages, is often symptom-free, exactly like many of the serious medical conditions associated with it, such as heart attacks, high blood pressure and strokes. In any case, lowering your H score will be a priority. And intelligent nutrients are one way of doing it.

Intelligent nutrients

The reason homocysteine accumulates in the body is because enzymes, the chemical catalysts in the biochemical transformation process, aren't working properly. Have a look at Figure 3. Here you can see the spotlight on the enzymes that keep your brain, liver and other body organs doing the right thing with sulphur and methyl groups.

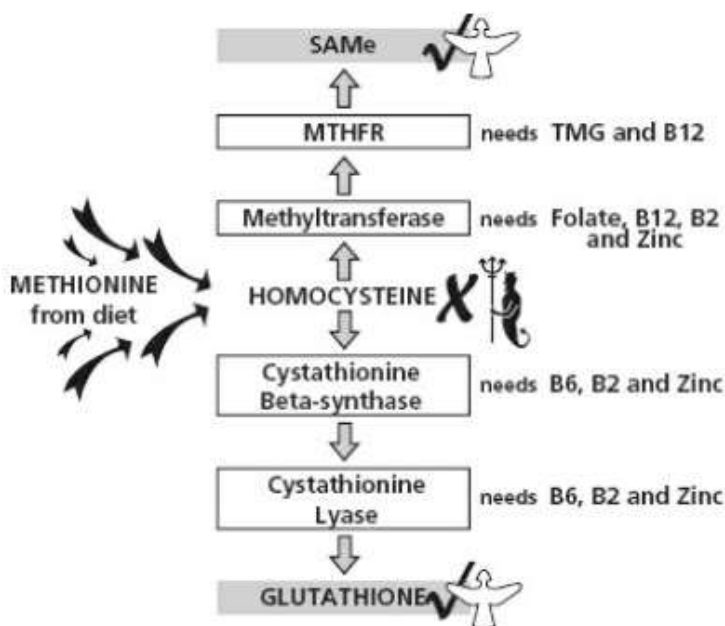


Figure 3. The main enzymes in the homocysteine pathway

Look at the diagram and you'll see that these enzymes don't work alone. They have helpers, called co-factors: primarily the vitamins folic acid (folate), pyridoxine (B6), cobalamin (B12), riboflavin (B2) and the mineral zinc. Among them is also a very special nutrient called TMG (for trimethylglycine), of which more later. These are listed below:

Enzymes and their co-factor nutrients	
Enzymes	Co-factor nutrients
Cystathionine beta-synthase	B6, B2 and zinc
Cystathionine lyase	B6 and zinc

Homocysteine methyltransferase	B12, folate and TMG
MTHFR B12,	B2, folate and zinc

So as you can see, the dance of homocysteine is mainly choreographed by these co-factors. The B vitamins among these are 'intelligent' in that they help you stay chemically flexible, well methylated, and in the best possible physical and mental health. As you will discover in Part 5, very few of us get enough of these nutrients from our diet, and certainly not enough to lower a high homocysteine level to an optimal level. The average intake of zinc, for example, is 7.5mg, which is only half the basic recommended daily allowance, or RDA.

Eat right and take your vitamins – and more

In the US, where homocysteine is now seen as superseding cholesterol as the best predictor for a heart attack, more and more health consumers are becoming B-vitamin crazy. And quite rightly, too. The American Medical Association published a report in 2001 suggesting that if every cardiovascular patient were to supplement B12 and folate, no less than 310,000 lives in the US alone would be saved in the next ten years. Meanwhile, the New England Journal of Medicine ran a lead editorial written by top cardiologists entitled 'Eat Right and Take a Multivitamin', again arguing that optimal intakes of these vital B vitamins can dramatically cut heart disease risk. Some critics continue to disparage daily vitamin and nutrient supplements, although this is rapidly becoming an old-fashioned view among the medical community. As you will see, however, the evidence shows clearly that eating a well-balanced diet is not enough in itself to lower high homocysteine to a safe level. But simply adding ordinary multivitamins to the equation won't do the trick, either. In fact, it could literally be a fatal mistake.

Why? Because the evidence shows, again and again, that if you have a high homocysteine level you'll need more than basic amounts of B vitamins. You'll also need 'methyl donors' – nutrients like TMG and SAME (both of which are available as supplements), which can donate an abundance of methyl groups to your body's chemical dance. And you need to remember to test your H levels regularly. The story of a 60-year-old man treated by the Life Extension Foundation in the US is a case in point. This man had bypass surgery and was suffering from chest pains caused by a relogging of his coronary arteries, a very common occurrence in heart surgery patients with high homocysteine. He was well aware of the dangers of high homocysteine and was supplementing 100mcg of folate a day (that's almost 1,000 times the RDA!) plus other key

homocysteine-lowering B vitamins. He was smart enough to have his H score retested. When he did, he discovered that his homocysteine level, although lower, was still in the extremely high-risk range, above 15 units. So, in addition to the key B vitamins, he began to take 6g of TMG. His H score then dropped dramatically to 4, indicating zero risk. This story shows why blindly supplementing with the big four B vitamins, and failing routinely to retest your homocysteine level or reassess your diet, can literally be a fatal mistake. If you want to live long and stay healthy, you need to know whether your regime is working for you, and what to do if it isn't. We will tell you how, step by step, later on in Parts 4 and 5, 'The H Factor Diet and Lifestyle' and 'The H Factor Supplements'.

Are you well methylated?

So, in addition to the vital big four 'methyl movers' – that's folate, B6, B12 and B2, plus zinc – we all need an abundance of the methyl groups themselves. These, as we've seen, are dispensed by methyl donors such as SAME and TMG. SAME is not necessarily the best nutrient to supplement, although it is very important within cells. As a supplement it is, among other things, both very unstable and very expensive to produce. In addition, lowering homocysteine naturally increases SAME levels. (Its special qualities are discussed in more detail on page 212 of Part 5.) Instead, TMG is the single best and most affordable methyl donor discovered so far. And as you will see, in combination with the big four B vitamins, it's the best homocysteine buster. TMG, as well as being available as a supplement, is formed naturally from choline, which is found in fish and eggs and so is easy to get from our diets – assuming we're not strict vegetarians! We'll be talking a lot about these nutrients later in the book. To summarise, a good starting point is to take the big four B vitamins and zinc, and make sure you are getting enough TMG and SAME.

Beyond homocysteine

These nutrients have amazing effects not only on your homocysteine levels but also on your day-to-day health. When levels are optimised, you'll find you have:

- Improved mood, memory and mental clarity
- Improved liver function
- Better condition of hair, skin and nails
- Increased energy
- Better sleep
- Reduction in arthritic pain
- Raised glutathione level (slowing the ageing process and aiding in detoxification)
- Dramatic reduction in risk of heart disease, strokes, cancer, and Alzheimer's.

And, of course, these nutrients can also dramatically lower your homocysteine risk within weeks, as part of the H Factor programme. So, you'll feel better AND dramatically reduce your risk of disease. We've looked in depth at homocysteine's place in body biochemistry. But to fully understand how vital it is to regulate this amino acid, let's have a detailed look at what high levels of it can do to the body.

Chapter 3: Ten reasons to lower your homocysteine

IN THE LAST CHAPTER we saw that the lower your H score, the better your body is at keeping the perfect balance of biochemicals, making you 'well-tuned'. This means more energy, more stamina and endurance, clearer thinking, fewer infections, and better skin and weight control. To give you a sense of how homocysteine, as a marker for your methyl IQ, is central to how your body and brain keep themselves healthy, here are ten good reasons for keeping it low and in balance.

1. Speeded-up oxidation and ageing

In the 1980s the spotlight fell on antioxidants such as vitamins A, C and E and the minerals zinc and selenium, all of which were found to have an important role in preventing ageing. When you process just about anything in your body, from food and drink to the air you breathe, you end up with damaged forms of oxygen called oxidants or 'free radicals'. The body makes a bucketful of oxidants every day just from processing oxygen and breaking down glucose, the body's main fuel. If you smoke, eat fried, browned or burnt food, exercise excessively, breathe in exhaust fumes, are exposed to strong sunlight, even suffer from chronic inflammation (which creates a vicious cycle of oxidant damage), you'll end up with even more. These oxidants damage your skin, your lungs, your digestive tract, your brain, your arteries and your DNA, the genetic code that keeps cells behaving properly. Oxidation triggers many diseases, including heart disease, strokes, cancers, and autoimmune disease such as rheumatoid arthritis¹⁰ and diabetes. We now know that high homocysteine dramatically and directly increases oxidation, and the damage caused by it.

2. Damage to your arteries

Increased oxidation is one way, but not the only way, that homocysteine damages your arteries. High homocysteine blood levels can cause blood cholesterol to change to a very dangerous form, called oxidised LDL cholesterol, which can severely attack artery walls. Once there's damage to your arteries, other types of cells begin to stick to your arterial walls. Among these are macrophages – immune cells that normally help to repair damage – and these are thought to be involved in developing atherosclerosis or the thickening of artery walls. In the presence of high homocysteine, macrophages become a lot stickier, causing ever thicker deposits in the arteries.¹¹ When this happens, all it would take for you to have a heart attack or stroke would be for a big blood clot to stick. And guess what? Homocysteine makes your blood clot much more easily than it should, increasing the risk of dangerous clots and sudden heart failure. Raised homocysteine also affects the flexibility of arteries, flexibility being one of the ways the body copes with any arterial clogging. It does this indirectly in two ways.

When oxidants, pushed by high homocysteine levels, damage the lining of arteries, the arteries begin to stiffen and the loss of flexibility causes blood pressure to rise dangerously high. High homocysteine (and low levels of folic acid) also affects a gas that's crucial to arterial flexibility: nitric oxide (NO). Some modern heart and blood pressure drugs are based on boosting NO activity in arteries. ¹² Homocysteine is now known to profoundly lower NO levels.¹³ When combined with increased oxidation, this makes a person with a high H score a prime candidate for a stroke or heart attack.¹⁴ In fact, having a high homocysteine level increases your risk of a heart attack or stroke by as much as 70 per cent. Depending on where one sets the safe range for homocysteine levels, at least 40 per cent of people with a history of strokes have abnormally high homocysteine levels, while at least 30 per cent of people with a history of heart attacks have very high homocysteine levels.

Of those 'at risk' of developing these diseases – people with high blood pressure or a family history of strokes or heart attacks, for example – at least 20 to 30 per cent have high homocysteine levels. That's a lot of people. We are conservatively talking about 1 million people in Britain and up to 8 million in the US. Despite all the evidence we've outlined here, virtually no doctors and far too few cardiologists routinely test for homocysteine. However, we predict that within the next ten years or so the number of tests will increase substantially. But with the abundance of published scientific evidence and ease and safety of treatment, who wants to wait that long?

3. A weakened immune system

Whether you are fighting a virus like the common cold, a bacterial infection (perhaps picked up from something you ate on holiday), an allergy or a rogue cancer cell, you need an immune system that's fighting fit. Your immune system attacks these invaders, but it is in turn attacked by

oxidants. As we saw above, these are everywhere and can do extreme damage if there are high levels of them. So the more antioxidants your immune army has available, the stronger it becomes and the more able to stop the damage wreaked by these invaders. The most important and powerful antioxidant of all is glutathione, which we met in Chapter 2. Glutathione is an essential sulphur-containing compound that lives inside your immune cells – in fact every cell – acting much like a benevolent police force. Oxidants also get produced when cells break down glucose to make energy, and glutathione helps mop up the cell's own 'exhaust fumes'. Since, as we've seen, excess oxidants speed up ageing, having high levels of glutathione inside your cells is some of the best health insurance you can have. Remember – lowered glutathione, like elevated homocysteine, is associated with an increased risk of early death from all common causes. So how do you boost your glutathione? One excellent way is to lower your homocysteine to a safe range. As you can see in Figure 2 on page 23, if you have a high homocysteine level, you are not making enough glutathione. With the right intake of B vitamins, zinc and methyl donors like TMG and S-adenosylmethionine (SAME), from both diet and supplements, you can raise glutathione levels.

4. Damage to your brain and a lowered IQ

One of the most sensitive organs of the body is your brain. Because it receives so much of your body's available oxygen from the blood supply and is active even when you are asleep or at rest, it is highly prone to oxidation – even more than your arteries or your joints when inflamed and damaged. For example, Alzheimer's is essentially an inflammatory disease, indicating increased oxidation. Even clinical depression and attention deficit hyperactivity disorder (ADHD) are linked to excessive oxidation. The brain's communication chemicals are what keep us alert, happy, calm and connected, and these all depend on methyl groups and proper methylation, which we explored in Chapter 2. Methylation keeps the brain's chemical messengers, the neurotransmitters, in balance, and so too brain function. But as we have learned, the 'dance' of methylation depends on getting enough B vitamins, zinc and essential nutrients such as SAME and TMG. So supplementing these in the right combination, which we'll learn about in Parts 4 and 5, will keep the workings of your brain in top condition. What about IQ, though? Back in the 1980s, we extensively tested the effects of raising schoolchildren's IQs using multivitamins. We proved, in double-blind trials published in the *Lancet*, that the simple addition of optimal amounts of vitamins and minerals, and especially B vitamins, could boost the average child's IQ score by nine points!¹⁵ We later found that those children with the lowest intake of B vitamins before being supplemented had the greatest improvement. And isn't it fascinating that among the B vitamins most effective in raising a child's IQ, it's the homocysteine-lowering folate, B2, B6 and B12 that stand out. If only we'd known more about homocysteine back then! Perhaps we would have found that the lower a child's homocysteine, the higher their IQ. That research has yet to be done.

5. Increased pain, inflammation and blood clotting

When the body is being insulted in some way, it reacts with redness, pain, tenderness, heat and swelling. This so-called inflammatory reaction occurs when you sprain your ankle or get stung by a bee, for instance. People suffering from arthritis or migraines also experience an inflammatory reaction. Most painkillers are anti-inflammatory drugs, helping to turn off the 'red alert' signal of the body. The main inflammatory messenger of the body is a hormone called prostaglandin E2, or PGE2, which is derived from an animal fat called arachidonic acid. High levels of arachidonic acid and PGE2 not only indicate a state of inflammation or emergency. They are also strongly linked to all sorts of disease, from heart attacks to strokes, Alzheimer's, cancer, and autoimmune diseases such as diabetes and arthritis. While inflammation is the body's short-term way of coping with an insult – for example, by isolating the poison from an insect bite by swelling, or stopping you from walking on that twisted ankle – prolonged inflammation actually damages joints, arteries and nerves. High homocysteine levels promote arachidonic acid release, an increase in PGE2 and hence inflammation.¹⁶ In the next part of this book, you'll see how high homocysteine levels are linked to most inflammatory diseases.

6. Vulnerability to cancer and problems with detoxification

Glutathione is essential in detoxifying the body and helping repair damaged DNA. So if you have a high H score, and therefore low glutathione, you will increase your risk of getting many kinds of cancer, and of premature cell death. Just about every cancer known is linked to glutathione deficiency, and many are linked to high homocysteine. Glutathione, along with SAME, is your liver's best friend, too. Any insult to the body – smoking, drinking, allergens, viruses, chemicals or drugs (both illegal and prescribed) – increases your need for glutathione and dramatically raises your homocysteine level. You may have a glutathione deficiency if you have smoker's cough, chronic bronchitis, asthmatic coughing and wheezing, difficulty concentrating, frequent headaches, food allergies and cravings, joint pain, muscle pain, frequent tiredness, irritability and mood swings, or recurrent colds and other infections.

7. A faster-ageing brain

In most people, 20 per cent of the 100 billion or more brain cells die over a lifetime. When you reach 70, your brain will have shrunk by 10 per cent. With this shrinkage often comes a gradual loss of control of the complex orchestra of hormones and neurotransmitters that keep you on the ball. The result can be diminished brainpower, slower memory retrieval, reduced sex drive, poor sleep, less energy, less motivation, chronic depression, social isolation and fewer highs. After the age of 75, one in ten people develop dementia, the most common form of which is Alzheimer's disease, characterised by a rapid loss of brain cells. This happens because DNA within brain cells gets oxidised and damaged by something called beta-amyloid. As you'll see in Chapter 13, the risk of developing Alzheimer's or just a declining memory is very strongly linked with high homocysteine. The big question is why. Recent research by Dr I. I. Kruman and colleagues from the Gerontology Research Center at the National Institute on Aging in the US may have the answer. Not surprisingly, they found that the higher the homocysteine, the less methylation and the less folate in the brain. The brain repairs its DNA via methylation, so low folate with resulting high homocysteine and poor methylation means more beta-amyloid-damaged brain cells and less effective repair of this damage. A double whammy. Happily, you can protect and rejuvenate existing brain cells at any age provided you have a safe level of homocysteine, and the right nutrients. This, along with the right lifestyle and attitude, means that age-related memory loss needn't happen to you. Research clearly shows that many healthy elderly people show no decline in mental function right up to death, and no increased rate of brain shrinkage even after 65.

8. Hormonal problems

Although we do not yet know exactly why, high homocysteine is strongly linked to oestrogen deficiency, which is particularly prevalent in post-menopausal women. This may also explain why the risk of heart disease is so much greater in women once they've passed the menopause. The fall-off in oestrogen leads to an increase in homocysteine and thus an increase in heart attack and stroke risk.¹⁹ Conversely, raising oestrogen levels in post-menopausal women tends to lower homocysteine. A recent study by Dr Hong Tao from the Department of Cardiology at Peking University First Hospital gave both men and women with coronary artery disease low doses of oestrogen. After six weeks they had, on average, a highly significant 14 per cent decrease in their homocysteine levels.²⁰ There was also a highly significant decrease in oxidised, or damaged, LDL (bad) cholesterol. So having enough oestrogen is good news as far as homocysteine is concerned. However, it is premature to recommend oestrogen HRT as a means to lower homocysteine, especially in the light of the known increased risk of breast cancer associated with HRT (see Chapter 30, 'Correct Oestrogen Deficiency'). There's quite a lot of accumulating evidence that lowering homocysteine may also help to keep your hormones in balance. In other words, it works both ways. This is discussed in Chapter 17, where you'll also find out that miscarriages and problem pregnancies are strongly linked to high homocysteine levels.

9. Deficiency in B vitamins

It is now proven beyond a doubt that, as we've seen, a lack of certain B vitamins raises homocysteine, and that enough B vitamins, plus zinc and methyl donors, can lower homocysteine into the superhealthy range. What this means is that your homocysteine level is now considered by many authorities to be the single best, most sensitive indicator of your B12 and folate status, and perhaps of your B6 status as well. Rather than shooting in the dark and assuming that your 'well-balanced diet', plus that daily multivitamin, are giving you all the B vitamins you need, you can find out for a fact by testing your homocysteine level.

10. Deficiency in SAME

As well as being the body's main methyl donor, SAME is the brain's master tuner. It helps keep you happy. In fact, there are over 100 double-blind studies in which volunteers given SAME or a dummy pill responded as well to SAME as to anti-depressant drugs, or even better.²¹ According to one review of these studies, 92 per cent of depressed patients responded to SAME and experienced far fewer side-effects, compared to 85 per cent taking standard anti-depressant medications. SAME also works fast. 'Most people taking SAME see some effect within 10 days,' says Dr Teodoro Bottiglieri, director of neuropharmacology at Baylor University Medical Center in Dallas, Texas. Of course, since SAME is the brain and body cells' most important methyl donor, you'd expect a wide range of benefits. And that's exactly what you'll find. SAME helps restore joint mobility and relieves pain in arthritis, helps reduce the muscle pain of fibromyalgia, helps enhance liver function²⁴ and protect against liver disease, and helps protect the brain from damage caused by oxidation. Roll on SAME! How do you know if your body is making enough SAME, and how do you encourage it to make more? Like glutathione and B vitamin status, your homocysteine level is also one of the very best indicators of your SAME status. The lower the level, the more SAME your body makes. With enough methyl groups, B vitamins and zinc around, up goes your SAME (and glutathione) and down goes your homocysteine. The moral of this story is simple. If you want to be in optimal health, with the longest, healthiest life possible, get your homocysteine level into the superhealthy range by following the H Factor programme.

PART 2 How's Your Homocysteine?

Chapter 4: Homocysteine – your most vital statistic

THERE'S AN OLD SAYING about the acceptance of new ideas. First sceptics and critics say, 'It's not true and not important.' Then they say 'It's true, but not important.' Then they say 'It's true, it's important, but it's not new!' This describes exactly what has happened with homocysteine. As we saw in Part 1, Dr Kilmer McCully struggled on the sidelines for over 20 years, waiting for the medical profession to take his discovery seriously. Then, in the mid-1990s things started to heat up. There was the Massachusetts-based Framingham Heart Study in 1995, which found that having more than 11.4 units of homocysteine in the blood dramatically increased the risk of heart disease.¹ Then, in 1997, a study published in the Journal of the American Medical Association proved that homocysteine was more important than cholesterol in predicting heart attacks and at least one in five people with a history of heart disease had 'high' levels. Homocysteine had entered the 'true, but not important' phase. In November 2002, a 'meta-analysis' of 92 of the best published scientific studies on homocysteine confirmed that homocysteine is not only a major risk factor for heart disease, but that it actually causes heart disease.² We believe that homocysteine is not only important, but that it is the single most vital health statistic.

More accurately than any other single measure, it can predict where you are on the scale of health, and whether you have a significant risk of all the major killer diseases, plus many, many others. It is more important than your weight, your blood pressure, your blood type or your cholesterol level. We hope that, within five to ten years, homocysteine will be a routine part of your medical check-up, right alongside cholesterol, blood pressure and blood sugar, and will be tested for by all knowledgeable and conscientious doctors in anyone suffering from or suspected of being at risk of disease. The good news is that you don't have to wait five years. You can take a

laboratory test to find out your H score now – either through an enlightened doctor, a nutrition consultant or even by yourself with an easy-to-use home test kit. You'll find the details in Chapter 7. As we outlined in Part 1, we also believe it is a potentially fatal mistake to assume that your homocysteine level is OK without testing just because you are symptom-free, eat a well-balanced diet or take vitamin supplements that include B vitamins. Some people, for both lifestyle and genetic reasons, are much more prone to high homocysteine and more resistant to conventional therapies than others. These risk factors are explained in detail in Chapter 6. In a nutshell, our review of over a thousand scientific research papers on homocysteine makes it clear that we all need to know our homocysteine level: it is of crucial importance in helping you identify what you personally need to do to stay in optimal health and free from disease.

How much is too much?

So, what level of homocysteine is healthy and what levels indicate what kind of risk? As more and more evidence is published in medical journals, the 'healthy' homocysteine level is moving lower and lower.

Below 15?

For many years a homocysteine value below 15 units was considered to be safe. This level has since been discarded almost universally among homocysteine researchers. It's much too high, and therefore much too dangerous. Above 14 units, you not only have a major risk of heart disease and strokes, but also double the chances of getting Alzheimer's later in life. Above 10.4 units, risk of certain cancers starts to increase. The Framingham Heart Study, remember, found that over 11.4 units of homocysteine in the blood significantly increased risk of heart disease.³ Many authorities have adopted this level as safe when evaluating patients. For example, here's what the American Academy of Family Physicians says: A healthy homocysteine level is less than 12 units. A level greater than 12 is considered high. If your homocysteine level is 12 to 15 units and you have blockages in any blood vessel, you need to lower your homocysteine to less than 12. If you have no other major risk factors for cardiovascular disease and you do not have atherosclerosis, it may be okay for you to have a modestly high level of homocysteine.

We emphatically disagree with this statement and think it is dangerous for reasons that will become clear. Other leading cardiology researchers think the optimal level is likely to be lower than the Framingham finding. A case in point is Dr Johan Ubbink and his team from South Africa's University of Pretoria. They compared those with risk of cardiovascular disease and those not at risk and determined the optimal homocysteine levels to be somewhere between 4.9 and 11.7 units. This is the range found in various studies to have the lowest risk and incidence of heart attacks, strokes and peripheral artery disease.

Below 9?

It has been found that cardiovascular patients whose H score is lower than 9 units and who have needed to have coronary angioplasty to unblock their arteries have significantly fewer new arterial blockages – which are a disturbingly common problem following heart surgery – and fewer cardiovascular disease complications later. This is consistent with what research shows about mothers and babies. Mothers who give birth to healthy, normal babies consistently have homocysteine values lower than 9 units. Above 9 units there is an increased risk of babies being born with congenital defects like cleft palates, club feet and spina bifida, or problems in pregnancy, including recurring miscarriages. The strongest evidence for setting a 'safe' homocysteine level at below 9 units comes from Norway. Researchers at the University of Bergen, the Department of Heart Disease at Haukeland University Hospital, and the National Health Screening Service in Oslo – widely recognised as one of the leading homocysteine research groups in the world – looked at the chances of 55-year-olds with coronary artery disease surviving five years, based solely on their homocysteine levels.