Appendix 1

CHOLESTEROL

In the acknowledgments section of this book I could have added a statement: "This book would not have been possible without cholesterol". But the cholesterol debate is so fundamentally important that I needed to give it this section, to clarify some scientific points to those readers who are interested.

If the 1960's diet-heart hypothesis, which linked cholesterol with heart disease (see chapter 7) had not existed, if scientists had not convinced governments of their theory, and if the governments had not advised their people to ditch saturated fat – then I don't think that we would have needed this book. The diet-heart hypothesis, which was supposed to stop the rise in heart disease, led to a chain of events culminating in another public health crisis - obesity.

We have all been subjected to public health campaigns, and media articles, explaining how saturated fat leads to heart disease - these have been omnipresent for 50 years. Once a critical mass of people, thought to be 10 to 25% of the population, are true believers in an idea, then the rest of the population will adopt that idea (Gladwell, 2002). This is what happened with the diet-heart hypothesis. This is why our populations now have a fat phobia.

Most people living in the West (including most doctors) will visualise the link between cholesterol and heart disease this way - *If you eat food containing saturated fats (like red meat) this will lead to high levels of cholesterol globules in the blood and these can somehow clog the blood vessels, cause narrowing of the coronary arteries and risking heart problems* – this picture is absolutely ingrained into our societies psych. This thinking is a very part of everyday life, everyday conversation. Now, when you see a fatty steak, or sausages (lots of fatty offal) your brain recalls this picture, of the greasy fat in the food clogging your blood vessels. We are now wary of steak, eggs, cheese and whole milk (unless we are French). As the cholesterol message is reinforced more and more (because the mass of believers is now so high) red meat and all dairy products, natural foods that have made up a good proportion of our diet for thousands of years, are now seen as bad for us.

Our governments advised us that it would be better for our health if we switched to a diet with less saturated fat - replacing it with grains (plant seeds) and vegetable oil (plant seeds). Food companies also followed the government advice, but had to add more refined wheat and sugar to make the low fat processed foods more palatable and therefore commercially viable. Our new diet, high in refined carbohydrates, meant that we needed to develop a snacking culture to help us cope with blood sugar fluxes between meals.

These changes to our diet – the high omegsa-6 from vegetable oils, and the elevated insulin from sugar and snacking led to the metabolic changes in our cells (insulin and leptin resistance) that encourage weight gain (chapters 8 and 9). These changes would not have occurred without the diet-heart hypothesis and the demonization of saturated fats.

The idea that saturated fat causes heart disease is just as ingrained in us as the knowledge that smoking causes lung cancer. However, unlike the irrefutable science linking smoking and cancer, the diet-heart hypothesis was based on evidence that has subsequently been discredited. Ancel Keys original studies (Keys, 1980), linking the saturated fat intake of a population to their rate of heart disease, was biased by the selection of only countries that fitted the hypothesis (France and Germany, who consumed high fat but didn't have high rates of heart disease were excluded). Confounding factors, such as the fact that sugar intake was also high in countries with high saturated fat intake – were ignored. Most recently it had come to light that scientists were paid large sums of money by the sugar industry to deflect the dietary blame for heart disease away from sugar and onto fats (Kearns, 2016). The powerful review article that these scientists published was to popularise the diet-heart hypothesis towards that critical mass of people needed for it to be accepted universally - as fact.

But recently the diet-heart hypothesis has started to unravel. There is increasing evidence that saturated fats from fresh foods (like red meat and dairy products) are *not* strongly associated with heart disease (Hamley, 2017) (Berger, 2015). Unfortunately, this message, from recent research, hasn't yet got through to policy makers. As we have learned in this book, top researchers and scientists, and influential doctors have vested interests. If an important public health message that they have been promoting for years is disproved then their reputations will be discredited and the funding for their labs may dry up – this is the reason that there is

so much inertia to that change in public health advice that is needed – too many people have their reputations and livelihoods tied up in the diet-heart hypothesis

Let's look at up to date evidence to unpick the diet-heart hypothesis and see where we currently stand – ***Is it ok to eat saturated fat or not?***

When the diet-heart hypothesis was gaining traction the only relevant blood test available was to measure total cholesterol levels. We now know that it is not the *total* amount of cholesterol in the blood that is important in heart disease risk, but the *vehicle* that the cholesterol is travelling within in the blood. Cholesterol is a fat and so cannot dissolve in blood (think of balsamic vinegar and olive oil – they don't mix). When travelling in the blood it needs to find its way inside water friendly carriages. These carriages are called LDL and HDL (meaning low density lipoprotein and high density lipoprotein). The LDL can be either type-A (small and tight particles) or type-B (large and fluffy).

The morning commute

Think of cholesterol molecules, travelling in the blood, as being similar-to people trying to get from home to work. Let's imagine that for their daily commute they must choose a vehicle to travel in. Some people take a big, hollow, red bus (driven safely, by a trained bus-driver – analogous to LDL-B) and others take tightly packed mini-vans (driven recklessly by freelance drivers – LDL-A). Think of the risk of heart disease being analogous to the risk of traffic accidents. Immediately you can see that if everyone travelled in safe red busses there would be very few accidents but when more and more people take mini-vans the accident rate goes up. It is not particularly the *amount* of people travelling that affects the number of traffic accidents but the *type* of transport that they choose. In the same way, this is how the risk for heart disease works. It is not the *total* amount of cholesterol travelling in the blood that is important but the *type* of transportation that it takes. If cholesterol takes more LDL type-B transport (red busses) the risk of heart disease is not increased, if cholesterol travels using LDL type-A transport (reckless mini-vans) the risk of heart disease increases. The *total* amount of cholesterol in the blood is only significant in people who have hereditary high cholesterol levels – this condition affects 1 in 500 people and leads to heart disease very early in life (in the 30's or 40's) – it is this hereditary condition that tricked researchers into thinking that cholesterol levels in everyone were an important factor in heart disease risk. In

most people, it is the *vehicles* that cholesterol uses to travel in that determine the risk of heart disease, not the total amount of cholesterol.

I want to introduce our third vehicle now. Interspersed with the busses and mini-vans on our commuter's roads are *police patrol cars*. As we know, as soon as a police car is around even the most reckless driver will behave for a while. In our analogy, the police patrols represent the effect of *HDL* on our cardiac risk. The more police cars on the road, the less the chance of accidents occurring. The more HDL in the blood the less the risk of heart disease. Police patrol car numbers are *the* most important variable affecting accident rate. When their numbers drop, accidents rise dramatically – in fact healthy *HDL levels confer much more protection against heart disease than any other factor*. All is calm when the police are patrolling but anarchy ensure when they are elsewhere!

If we conclude that it is not the *total amount* of cholesterol in the blood that defines the risk of heart disease, but the *type of transport* that the cholesterol uses, then the next question should be – what determines which type of transport cholesterol uses?

If the original diet-heart hypothesis were correct – that saturated fats causes heart disease - then we could conclude that increased consumption of these fats causes cholesterol to use LDL type-A cholesterol (mini-vans) as their preferred mode of transport. But when the hypothesis was originally formulated, the types of vehicle that cholesterol travelled in was not known - only the total amount of blood cholesterol could be measured. We know from these early studies that a high dietary cholesterol intake does indeed increase *total* blood cholesterol slightly (the number of morning commuters in our analogy) and therefore that more cholesterol carrying vehicles will be needed. But here is the catch - the higher cholesterol traffic from saturated fat does *not* increase the ratio of LDL type-A vehicles (mini-vans) compared to LDL type-B vehicles (busses). The total number of LDL (busses and mini-vans combined) increases but the proportion of good type-B (busses) is increased and bad-type-A (mini-vans) is actually *decreased*. After eating saturated fat, the level of good-HDL cholesterol (police patrol cars) also increases, protecting against heart disease. *In summary commuters are predominantly taking safe red busses, with less taking reckless mini-vans, and there is a high police presence*. This evidence would suggest that consuming saturated fats *does not* cause heart disease – and that the diet-heart hypothesis is wrong.

What other factors could change the cholesterol traffic in our bloodstream? Let's expand our analogy further. Let's say commuters have to walk to a bus stop to catch a bus but that crowded mini-van will come to their doorstep.

If there is a torrential rainstorm commuters are less likely to risk being soaked and therefore mini-bus traffic increases, leading to more accidents. In dietary terms our rainstorm is produced by a different type of fat to cholesterol – the biological thunder and lightning is produced by **trans-fats**. As we have learned, trans-fats are present in many processed foods (including cakes, biscuits and processed meats) and are also produced when vegetable oils are heated to a high temperature. Some of the earlier studies linking saturated fats to heart disease failed to take into account the effect of trans-fats on cholesterol commuter traffic – reinforcing the belief that saturated fats were dangerous (De Souza, 2015).

What about a snowstorm? Again, commuters will take the more convenient mini-vans rather than risk slipping over on the walk to the bus stop. The roads will be treacherous and again accidents will increase. For our cholesterol particles, the dietary equivalent to a snowstorm occurs when we take in – you guessed it – **sugar** (Siri, 2005) (Krauss, 2010).

How about if the sun comes out (if you are reading this from a sunny country bear in mind that a sunny day is a rare event in England)? Commuters want to enjoy their walk to the bus stop and avoid those sweaty, crowded mini-vans. In addition, there are more police cruising the streets (as they are less likely to call in sick on a sunny day). The result? Safe travel and no accidents. We can reproduce these idyllic cholesterol travel conditions within our bloodstream by something that costs nothing - **exercise** (Durstine, 2002).

So, in summary there are various dietary and lifestyle factors that affect the mode of transport that cholesterol takes and therefore affect the risk of heart disease. The most dangerous factors are sugar and the trans-fats in processed foods (snow and stormy conditions in our analogy), recent studies suggest that saturated fats from natural foods are not a significant risk, and exercise (our sunny day) is cardio-protective.

Good cop…

Over the last 10 years the growing acceptance that total cholesterol is *not* a dependable risk factor for heart disease has led to new additions to our everyday vocabulary – *good cholesterol and bad cholesterol*. Good cholesterol is HDL (police patrol cars). But *bad* cholesterol is still used to describe *both* types of LDL – type-A and type-B. This means that both our dangerous mini-vans and safe red busses are lumped together and described as BAD. This has confounded the analysis of dietary risk, particularly of saturated fats and muddied the research waters. It is almost as if some researchers are searching for vehicles through a thick fog. Why is this? Why is this thick fog obscuring the truth about something so important to public health? I personally am not sure, but suspect that vested interests of top researcher institutions may play a part. We know that the direction of research is still, unfortunately, under the influence of the companies providing the funding for research labs. Scientists now must disclose their funding but this does not stop the direction of research that they take – it just makes it easier to interpret whether there may be bias involved. What would be the reason that *all* LDL should be thought of as bad?

The biggest selling class of drugs in the world are the *statins*. According to a recent IMS report statin revenues reached *$35 billion* in 2010. These drugs have been shown to reduce total cholesterol levels in the blood by blocking some of its production in the liver. As well as reducing total cholesterol levels statins also decrease the risk of heart problems in some patients. But many researchers now doubt that the effect of statins on heart disease is related to cholesterol – there is increasing evidence that they work to reduce inflammation in the cardiac blood vessels. If this is the case then why does the American Heart Association, a body of experts that the rest of the world look to for guidance, still follow the diet-heart hypothesis – insisting that LDL-cholesterol (both types) is the most important marker of cardiac risk? And insisting on a diet low in saturated fats? In fact, their recent guidelines have recommended *lowering* the threshold of blood cholesterol level appropriate for statin treatment (Sacks, 2017). Guidelines based on a meta-analysis (summary of all many previous studies) that excluded an important body of research on LDL subtypes (Krauss R. , 1995). It is as if this research does not exist and suggests a degree of research bias. Many doctors around the world look to these guidelines in order to decide when to prescribe statins, and if the diet-heart hypothesis remains valid then statins will remain bestsellers.

A particular saturated fat that has raised concern is *palmitic acid*. A report by the World Health Organisation (WHO, 2003) has suggested that there is convincing evidence that the consumption of this type of fat can lead to heart disease. Palmitic acid is present in all types of meat and also in dairy products – but in small amounts. The pure form of palmitic acid is made from simply heating up palm oil to extremely high temperatures – this can be done on an open fire and it constitutes the main cooking oil used in African villages. Palm oil, when added to foods adds a nice texture and taste, and come at a cheap price. The result, it is contained in large amounts in processed foods. It is from these foods where I think the association of palmitic acid with heart disease arises – and not from the small amounts present in natural fats such as red meat, cheese and milk.

A recent independent meta-analysis of *all* the previous studies that looked at the relationship between saturated fats in the diet and the risk of death failed to show any increased risk - in particular, no increased risk of developing heart disease, having a stroke or developing diabetes (De Souza, 2015).

Statins undoubtedly work in some cases but I suspect that the rational for prescribing them – high LDL and only slightly elevated total cholesterol levels inflates the amount of them prescribed. This research certainly suits the pharmaceutical companies who produce the statins, but why are some medical associations (like the AHA) ignoring valid scientific research? What is the benefit for them? I will leave you to decide. Unfortunately, the perpetuation of the diet-heart hypothesis in the face of contradictory research means that dietary guidelines are stuck with the recommendation to avoid saturated fats from natural foods and replace them with grains and artificial oils. Without these issues being addressed our populations will still be guided to consume an obesogenic diet – and obesity will remain our major public health problem.

SUMMARY

- Eating saturated fat can increase blood cholesterol levels
- Avoiding saturated fat can lower cholesterol levels
- Cholesterol is carried in the blood within HDL (police) and LDL
- LDL is split into LDL type-A (mini-vans) and LDL type-B (busses)
- HDL is protective against heart disease
- LDL type-A triggers heart disease
- *Total* cholesterol level is a poor measure of cardiac risk
    - But very high cholesterol levels (seen in rare hereditary conditions) increase risk of heart disease
- **Saturated fats, and exercise increase HDL levels**
- **Sugars and refined grains increase LDL type-A**
    - By increasing insulin
    - Insulin stimulates conversion of sugar to fat in the liver
    - The liver sends LDL type-A into the blood (Savage, 2010)
- Increasing carbohydrate in the diet in place of fat increases LDL type-A
- Increasing fats in the diet in place of carbohydrates decreases LDL type-A (Kraus, 2001)

STATINS

- Reduce total blood cholesterol level
- Reduce the risk of heart attacks in men over 65 years
- Work by reducing inflammation