Macronutrients: Fat Structure and Function

Transcript

Hello and welcome to our Institute for Nutritional Endocrinology *Module on Fats* as a part of the *Macronutrients* Module. This video is about *Fat Structure and Function*. Fats are this misunderstood and maligned creature and I want to clarify what the value of fats are in our body, the functions that they have, the structure that they take on, and how you can help your clients to balance their fats and optimize their functioning.

Before we begin, all the information that I share is from my experience and my expertise. It's not meant to replace a one-on-one relationship with a medical professional. It's not medical advice, it's sharing.

In the same way when you are sharing with your clients about fats and how they work in their body, make sure if they are under the care of a medical professional, that they are checking in and are not doing anything that is out of alignment with the care that they are being offered.

Our *Macronutrients* Module is composed of four main pieces: *Water*, which a lot of people don't even think of as a nutrient but is a very critical nutrient and we've already been through that, *Fat, Protein* and *Carbohydrates*. The fat, protein and carbohydrate provide the calories in your diet. Those are called the *Macro*nutrients.

The *Vitamins*, *Minerals* and *Antioxidants* are called the *Micro*nutrients. They don't have caloric value, or energy value, in the system, but they have some very important functions. Within the *Macronutrients* we've already given you a talk on Water, the current one is on Fat, and then we are going to go into Protein and Carbohydrates.

What you will learn in this presentation is a number of things: first of all the importance of fat in the body. Fat has been given a bad rap: 'low fat', 'no fat', 'bad fat'. We are going to learn about bad fats, good fats, fats that support structure and function, fats that reduce the viability of structure and function, fats that interfere with these.

I'm going to teach you the basic underlying components of fats so that you can understand how to counsel your patients and clients about how to use fats in their diets. We are going to look at the different categories of fat. I won't spill the beans now, but I will in a shortly. We will look at the chemical structure of fats.

For those of you who love to geek out on biochemistry like I do, you are going to love this piece.

For those of you who don't, I'm really simplifying it down so that it demystifies fats, as well as in future modules, the proteins and the carbohydrates. The chemical structure is really important to understand and again it takes away some of the mystique and the mystery.

We will talk about the omega classification of polyunsaturated fats and also monounsaturated fats, so really the omega classification of *un*saturated fats. We will talk about what saturated fats are versus unsaturated fats, and really take away the cloud of mystery about Omega-3, Omega-6, Omega-9, what does that really mean? We will go into the chemical structure in order to do that.

We will look at the omega fat naming conventions: it's really not a naming convention that you are going to see on bottles and labels. But if you go out start to do research on particular diseases, or conditions, or food components, and you see the way that fats, the nomenclature that's used, I want to demystify what they call them, and the numbers. I want to make sure that you understand that.

We are going to look at essential fats versus non-essential fats, and why non-essential fats are really not. It's not that they are not essential to human functioning, it refers to what is in the diet: the ability to make fats, which are the non-essential fats, and the essential fats.

the truth of the matter is, you need to have enough essential fats in order to have the raw materials to make what's called the non-essentials. And we'll see that those have very essential functioning, as well as the essentials. We'll look at the refining and processing of fats, what that actually does to the chemical structure and to the function.

Let's take a look at the various places that fats are important in the body. Fats are not things to be avoided at all costs. Fats have very important functions in the body. You probably know that a big part of the brain is fat. Really it's estimated to be more than half: approximately 60% fat in the brain. The fat in the brain helps to protect and speed up the transmission of the neurons.

Did you know that 25% of the cholesterol is in the brain? We talk about cholesterol being the bad guy when, in fact, it's really not. It's *excess* cholesterol and *oxidized* cholesterol that's really the problem. Cholesterol, in general, is a precursor to the steroid hormones in the body and also makes up about 25% of the brain. It's the precursors of the steroid hormones: the adrenals and the sex hormones. We'll look at those in detail later. It's also important for the regulation of blood pressure. Did you know that the cell membranes are mostly fat?

I always tell people you wear your fat. So if you eat good, wholesome fats that have not been oxidized, that are really good structurally, they become your cell membranes. Then your cell membranes can really be giving and taking of nutrients and waste appropriately. But when you, or your client, eat fats that have been rancid, oxidized, or highly processed, those fats become the cell membranes, and then the functioning of those cell membranes is not good, and that's what leads to toxicity and disease.

Your myelin sheaths are fats. Myelin sheaths are the coating around the neurons, which makes it so that you can think 'move your foot' and your foot moves instantaneously even though the thought happened in your head, the foot is way down. It could be as much as six and a half feet down, for many of us it's five and a half feet down; the average adult woman is less than five and a half feet.

That's a long way to go and it happens in a millisecond. When people have problems with myelin sheaths, as in the disease called multiple sclerosis, which is a demyelinating disease, then they don't have that luxury that we have of thinking 'move your foot' and it moves. That function in every step is challenging because it's a slow process to get the signal from the brain to the foot to move it. That's another reason why it's super important.

Your hair and skin need fat. Have you ever seen people with really dry hair and skin, flaky scalp? You will see that in your practice, and they need fats, especially essential fats to have that fluidity and that moisture. The immune system needs fats. Fats are important for the inflammatory cascades, which we will look at in a video that follows this video.

Fat, especially dietary fat is going to improve the absorption of fat-soluble vitamins. A lot of people go on low-fat or no-fat diets, and what they don't realize is that that's going to impair the uptake of vitamin A, and the conversion of beta-carotene to Vitamin A, and the uptake of Vitamin D should you be taking it in a liquid orally, and of E and K. Those are the fat-soluble vitamins, and we'll go into a lot more detail about those vitamins in another segment.

Let's look at the importance of fats in the body a little further. This is a study that was done on the absorption and conversion of beta-carotene to Vitamin A. Vitamin A is a pro Vitamin A, the body has to convert two beta-carotenes and convert them to one molecule of Vitamin A.

Beta-carotene is abundant in our food supply. It's abundant in green leafy vegetables and lots of your rainbow vegetables. This was a study that looked at a cup of fresh avocado was added to a salad consisting of romaine lettuce, spinach and carrots. What happened was it increased the carotenoids from this salad between 200 and 400% just by adding a little fat.

That avocado could have been cashew butter, it could have been macadamia nuts, it could have been sunflower seeds, hemp seeds, chia seeds, flax oil, coconut oil: it could have been any number of those foods. This particular study looked at avocado, which of course is delicious.

Let's get down to the meat and potatoes, if you will, of dietary fats: the categories of fats. I'm sure you've heard of these before. You probably understand to an extent what these are: saturated fats, monounsaturated fats and polyunsaturated fats.

Just by looking at those words you might be able to guess what that means, but if you don't understand the science behind it, you don't really get it. You may think saturated fats are bad and polyunsaturated fats are good. It's actually a misconception because some saturated fats can be really good for you, and many polyunsaturated fats can be really bad for you.

When you throw the balance out of whack with omegas on the polyunsaturated fats, then you really get into trouble. We are going to talk about those omegas and their effect. Then we have monounsaturated fats. I'm not going to explain to you what each of these fats are because I'd rather do a picture. A picture is worth a thousand words.

But the list of foods that have saturated fats, significant amounts of saturated fats, would be meat, dairy, butter, cheese, ghee, eggs, coconut and palm. There's a little bit of saturated fats in things like cashews and macadamia nuts but the predominant sources are the ones that I just listed.

Monounsaturated fats, the ones we think of the most are olives, but macadamia nuts are very high in monounsaturated fats, as well as cashews, hazelnuts, avocado, sesame seeds, pecans and almonds. There is a chart that shows you the exact amounts and percentages of these, so if you are looking to get balance in someone there are ways you can do it by helping them to choose from the chart.

Finally the polyunsaturated fats are abundant in nuts and seeds, grains and vegetables, legumes and fish. You can see that most of the monos and the polys are in your plant-based foods, most of the saturates are in your animal-based foods, but there is a crossover. Let's look at fatty acids. This is a diagram of a fatty acid. Fatty acids are the building blocks of fats.

When we look at omega 3s and omega 6s, and when we look at a long, big fat molecule it's broken up into a variety of fatty acids. Carboxylic acid with a long carbon chain, what does that mean? Carboxylic acid is a COOH (and we'll look at a picture of it in a second) with a long string of carbons with hydrogens hanging off them.

I'll go through a picture of it so you can see what a saturated fat, an unsaturated fat and a polyunsaturated fat looks like, and the effect that that has on the carbon bonds. They differ in length. In the nomenclature of fats you may see a C, which would be the number of carbons (often the C is left off, it's just inferred). C22:1:9 would be a fat that has 22 carbons, one double bond and that double bond is on the ninth carbon, between the ninth and the tenth, I believe.

Most fatty acids have between 10 and 20, but there are several that are called long chain fats, like EPA and DHA, which you may have heard of, that go up to 22 and 24 carbons.

Most have an even number of carbons, but there are a couple of exceptions. Linoleic acid, an omega 6 fatty acid, would be listed as 18 or CC18:2, which means there are two double bonds there so it's polyunsaturated. Unsaturated means that all of the bonds in the saturated fats are single bonds, which means that every single bond there can be is saturated with carbon, every carbon has its full share of hydrogens hanging off of it.

For every bond it could have, it has. Whereas the double bonds mean that there are two bonds between two carbons and then that number of those relates to whether it's a polyunsaturated or a saturated.

Linolenic acid is 18:2n-6 which means it has two double bonds, two unsaturated bonds, 18 carbons total, and then the n-6 means that it's an Omega 6.

Sometimes it would be listed as 18:2:6, different nomenclatures, different locations. The first double bond is at the sixth carbon from the methyl end. We have a carbon chain, we have a methyl group on one, which is CH3 and we have a carboxyl group on the other, which is COOH.

Here is a picture. We have saturated, polyunsaturated and monounsaturated cores in the middle, and on the end we have what's common to all of those. On the left-hand side we have a carboxylic group, which is a carbon, a double bond to one oxygen, single bond to another oxygen and then another hydrogen. It's often listed as COOH, a carboxyl group.

On the other end we have a methyl group. If you've done any study in the genetics/ genomics area, you will know of methylation. Methylation means adding a methyl group, a CH3, to a particular chemical structure.

At the top that's a saturated fat. You'll see that between every carbon there's one single bond and then above and below is a bond to a hydrogen. Every single one of those bonds is saturated and that's why it's called saturated. This is just a little snippet because most of these are going to be between 12 and 20 and up to 24 carbons. This is just to show you.

That saturated fat would have this carboxylic group on the one side, it would have a methyl group on the other, and it would have a string of carbons in the middle, all of which have their full potential of hydrogens attached. A polyunsaturated fat is a fat that does not have all single bonds between its carbons, it doesn't have hydrogen on every single carbon (meaning saturated).

It has several carbons that do not have hydrogen because they are double bonded to each other. We see that here in this picture where number 1 is, that's a double bond, got it? And then the other one, number 2, is a double bond carbon to carbon, which means that for every double bond there are two less hydrogens.

This is a polyunsaturated fat. We will go into the omega 3 and omega 6 designations in a moment, and tell you what that really means. What it means is the placement of the first double bond. A monounsaturated fat, on the other hand, just has one double bond so it's two less hydrogens than its saturated counterpart.

Let's go into a little bit more detail about these fats, what they are, what they do, and what they look like. Here's a full-blown saturated fat laid out. This particular saturated fat has 16 carbons so it would be designated as C16 or sometimes just 16, and then for every carbon it's got two hydrogens which will make it 32 plus it's got two more on the ends so it's got 34.So it would be C16H34O2. If we were naming this, we would name it just basically C16 because we know it's saturated therefore we don't have to know how many double bonds and where those bonds are located.

What's listed here are some of the most common saturated fats. There are dozens of them, even hundreds.

I've marked in orange the ones that you might see often like butyric acid, which is found in butter and it's also an important one that is in the gut, in the large intestine, which helps with the gut flora. Caprylic acid, you may have heard of, it's part of coconut and it is very useful as an antifungal. Often you'll see caprylic acid used as an antifungal for people with candida overgrowth.

Lauric acid is another one found in coconut: coconut is a really good source of saturated fats. Lauric acid has two big roles amongst others. One is that it's a very potent anti-viral, and the other is it helps with the conversion of short chain omega 3s to long chain. We'll go into that more in our video on inflammation.

Then there is myristic acid, which is a C14 also found in coconut. It has been found to profoundly improve the conversion of omega 3 short fats, which are found in the vegetable kingdom like alpha-linolenic acid into the long chains, which are EPA and DHA. We'll show you these shortly in some of these charts.

Those are the main ones. Another one on the right-hand side that you may know is stearic acid and it's the third one down, it's a C18. Stearic acid is often used as a lubricant/binder/filler in supplements.

Now let's look at the unsaturated fats. We have two classes: monounsaturated means they have one double bond, and polyunsaturated means they have two or more double bonds.

Some of the most commons ones are here on the slide. The most common one that you hear about is oleic acid (pictured here on the slide), which has 18 carbons: 18:1 means that it's 18, colon one means that it's got one double bond.

We didn't write where the bond was because I think all of these are actually omega 9s, they are at the ninth position. The omega 9 means that if you count from the methyl end of the fat which is the CH3, this part, you will count the carbons 1 to 9, and then right after the ninth one you see the double bond and then you go back and see the rest: since this is 18 you'll have 9 and 9. It's always from the methyl end that you count.

Sometimes you will see this picture differently and some of these molecules could be very confusing. I'll show you that in a moment. Of the omegas, a few of them stand out. We don't spend a lot of time studying these, but you certainly could investigate if you have a client who is not responding and you think there might be some unusual fatty acid problem, or a genetic problem. But oleic acid is the one that's most commonly used and we'll show you later in the presentation where that's found and how much in different foods.

Nervonic acid is one that I came across some very interesting research, which may play a very big role in some of our clients who are having neurological issues, slow nerve conduction issues, even MS or precursors to MS. We'll look at that in a minute and that's a 24-carbon, they are all 1s here.

Let's look at polyunsaturated fats. This shows the bend. Most of the polyunsaturated, or even the monounsaturated, in the real world of three-dimensional molecules, will have a bend where a fatty acid double bond is.

In this particular case if you look, it's the opposite: the carboxyl group is on the right and the methyl group is on the left. This is the way I found the picture. I could have flipped it to make it less confusing for you, but I wanted you to see that at times you have to look to see where the carboxyl side or the methyl side is.

If you go to the methyl side, we count to see where the first double bond occurs, and it's at 3, which means this is an omega 3 fat. It's an omega 3 fat that has two double bonds and 18 carbons so it's 18 carbons, two double bonds, the first one is at 3. On here you are going to see some that you recognize and you are going to see some that don't. I just put them in there so that if you do see these in various documents or studies that they won't be completely foreign to you. I wouldn't expect you to remember any except the ones that we go through in detail.

The ones that we are going to go through in more detail are linoleic which is one of our essential fats, alpha-linolenic which is another one of our essential fats, they are omega 6 and 3 respectively, they are both 18-carbon fats. Then we have gamma linolenic acid, which is in the omega 6 side.

The next one of importance would be Eicosapentaenoic (EPA) which is on the omega 3 side, Arachidonic acid which is on the omega 6 side, Docosahexaenoic (DHA) and we see these a lot and these are very important fats in human metabolism and fats that you can actually manipulate in the diet.

We'll do another quick look. You see how they are bent, you have a carbon and they form these little diagonals? That's really the way they are in nature. The straight ones across are simply put out that way to make it easier to read on the paper, but this is what it really looks like. The top one is alpha-linolenic and you can see the third on the left, it doesn't show that it's a CH3 but we are just assuming because that's the way it's listed.

The third one is the first double bond and then there's another one at 6 and there's another one at 9. So this one has double bonds at 3, 6 and 9 and it has 18 carbons. Linoleic, the other one of the essential fats, has got the first bond at 6 so it's an omega 6 and it actually has two double bonds.

Let's talk briefly now about essential fats versus non-essential fats. Essential fats are fats that the body cannot make; they need to be supplied from the diet.

These are fats that you will be advising your clients to take on a regular basis. The two essential fats we have are alpha-linolenic acid and linoleic acid. ALA is the omega 3 and LA is the omega 6. [Memory tip: alpha-linolenic acid is **three** words and is an omega **three**]

Let's talk about *essential* versus *non-essential*. *Essential* means that your body cannot make it: it has to come from the outside. It's a precursor and a building block for other fats. Your body doesn't have the mechanism to make it.

Non-essential means that your body could make it as long as it has extras of the essential fats. I've listed some of the omega 3s and 6s and 9s that you might recognize. ALA is found in flax seeds, chia seeds, hemp seeds, walnuts, and other foods, but these have the most significant amounts. EPA (Eicosapentaenoic acid) and DHA (Docosahexaenoic acid) are very important fats. EPA is important for the inflammatory pathways, and we'll go into more detail on those on the next video.

DHA is important for brain function and blood sugar management. It's a very important nutrient. Both of those are marine lipids, meaning they are found in the sea. They are most abundant in fish, but they are also found in algaes because fish eat algae.

If you eat enough algae, you certainly get enough EPA and DHA, but you've got to take enough. The oils tend to be good sources because they are more concentrated. In the omega 6s we have linoleic acid: found in sunflower seeds, pumpkin seeds, almonds and all your vegetable oils. It's abundant in the diet.

In fact we look at the ratios, most people get too much linoleic (6), but not enough linolenic (3). Downstream from the elongation product of linoleic acid, is gamma-linolenic acid and gamma-linolenic acid is found in things that we don't often eat a lot of but could be taken in supplemental form like evening primrose oil, borage oil, and blackcurrant oil. These tend to be the highest sources. Hemp seeds are a good source of GLA too that most people overlook.

Then we have dihomo-gamma-linolenic acid (DGLA). It's not found in foods per se: it is a conversion product. Gamma-linolenic turns into dihomo-gamma-linolenic, and this takes it down the anti-inflammatory pathway. When we don't have enough of the omega 3s or we have some other confounding situations (which we'll look at in more detail in the inflammation video), then the GLA goes down to DGLA, which goes to arachidonic acid, which is an inflammatory fatty acid.

This will become very clear when we do the next presentation in this module. On the omega 9 side, the most predominant ones that we know about are oleic and nervonic.

Here are some lists. These are for your reference if you want to look up which category a fatty acid belongs to, or are looking up a person's essential fatty acid or full fatty acid panel and trying to understand what it is. A lot of these I don't know what they are or do, we just need to look them up if we suspect a problem.

If I was looking at a fatty acid test and I saw that eicosatetraenoic acid was low, other than being a direct precursor for eicosapentaenoic acid (EPA), I don't know what it really is and I don't think it's important to memorize. Omega 6 fats (we are looking at the nomenclature here): linoleic acid (LA) (18:2 n-6) is an 18-carbon with two unsaturated bonds; the first one is at 6.

Gamma linolenic acid is 18:3 n-6, so it's got a third one. Same length but it's got a third one and it completely changes the function. Gamma-linolenic acid is often used for hormone balance, sometimes used for brain chemistry balance, very different from linoleic acid, just by addition of that one extra double bond and the removal of two hydrogens.

Eicosadienoic acid comes between that and GLA which is acid. It's a 20 with two double bonds which then goes to DGLA which is a 20 with three double bonds, so they are getting longer. Next one would be arachidonic acid, which is through inflammatory and tends to push things down towards the inflammation pathways and that's a 24.

You can see there's not a lot of difference between these molecules in terms of what they look like structurally but there's a huge difference in the way that they act. You will see as we go through our studies together that certain things look almost identical like estrogen and testosterone. They look almost identical on paper, but look at the differences it makes in people, huge difference.

This is a chart, it may or may not be very readable on the screen, but you have a printout of it for reference. It has animal fats at the top and vegetable fats at the bottom. It's showing saturated, monounsaturated, polyunsaturated and then cholesterol and Vitamin E. You can see that the only things that have cholesterol in them are the animal fats.

In terms of Vitamin E content there's a wide variety in these fats. If you look at coconut oil, which is 0.66mg/100g, it doesn't have a lot of Vitamin E compared to wheat germ oil, which is loaded with Vitamin E at 136mg/100g. Hemp oil is pretty decent, holding its own at 12.34. We would recommend that you take hemp and olive, which have decent levels of Vitamin E.

None of them has cholesterol because it's a plant, and plants don't have cholesterol. This is just a reference chart.

What happens if these omega 3s and 6s aren't in balance? I'm sure you've heard before 'keep your omega 3 and 6 ratio in balance.' I'd like to share with you what that really means and what the implications are.

That's the symbol for the Greek letter, omega, and when things are out of balance, when we have too much omega 6 and not enough omega 3, we will push pathways down towards the inflammation side. We'll see more of that in our next part, which is the pain and inflammation section. Heart disease: it's been shown to be an independent risk factor and it could be because of the inflammation. It causes inflammation in the blood vessels and that creates problems.

Clotting disorders have been found to be associated with increased omega 6 versus 3. Hormonal imbalance is big time, you really need this balance of omega 3 and 6 or else you get into some inflammatory pathways and spasming pathways. When hormone receptors get inflamed they don't do their job of picking up the hormones.

Depression and anxiety, we see so many people suffering from depression and anxiety and when we look at their fats they are way out of balance. It's said that when you look at the omega 3s and 6s on a blood panel, you are looking for about a 3:1 ratio of omega 6 to omega 3. That might be opposite of what you think. You say 'omega 3s are good, why aren't they more?' It's just what has been found to be optimal.

What the studies are showing when they correlate the symptomology with the test results, is that people who are depressed tend to have super high scores. Their omega 6 to 3 ratio might be 15 or higher. It's also true for other autoimmune and inflammatory diseases. The idea is to nip this in the bud and to really focus on the right amount of omega 3 and 6s. It's not as easy to get omega 3s, you have to work at it. But it's sure worth the work.

Autoimmune diseases are affected by this, big time, because of the inflammatory component. Asthma, same thing, bronchioles get inflamed. Rashes, if your body is not able to maintain the balance of fatty acids then you don't get the nice, smooth, glowing skin and you get flaky skin and dandruff.

Let's take a look at a fatty acid lab result. We'll go more into this: we have a whole module where we are going to talk about fatty acid testing, how you do it, what it's about, case studies; so you get really good at it because it's a very important test. This particular one is from a lab called *Metametrix* also known now as *Genova* because they merged. Let's take a look at what's shown on this blood fatty acid test.

This one we call a 'Bloodspot Fatty Acid' test because it only takes a drop of blood. You do the same as you would normally do if you were testing your blood glucose, which I've shown you before, and you put it on the card and send it off to the lab. They don't have a way of developing it locally yet, so that way you can do a completely independent blood test, but I'm sure it's coming in the near future.

We have the polyunsaturates and the omega 3s. These are the basic tests. They have more elaborate tests, but I find that you can get so much information from this. I'm going to give you a quick peek on what kind of information you can get from it, should you want to do some of these tests. Know that we are going to go into a lot more detail in a module further down the road.

Alpha-linolenic acid, where does it come from? Do you remember? It comes from flax seeds, chia seeds, hemp seeds, and walnuts.

If you've got high levels of the omega 3, ALA, and you have very low levels of the DHA and EPA, which are elongated versions, then that means you are not converting properly. If we look at this one, this person actually has pretty low ALA, it's in the second quartile and moderate EPA which makes me think that maybe they are taking an EPA supplement, and very low DHA.

Barring genetic factors, I would be guessing that this person could improve dramatically by adding some omega 3 rich foods to their diet like flax seeds, chia seeds, hemp seeds, pumpkin seeds, and deep ocean fish, mainly because they are just plum low.

Omega 6s: we have linoleic acid and that's close to the end of the third quartile, we have gamma linolenic, which is what it flows down into, and there are some co-factors, we'll revisit that in our section on inflammation. In this case we have high levels of LA, not surprising because linoleic acid is found everywhere.

Then we have the GLA, which is lower, which can indicate that although the linoleic is high enough, maybe this person has been taking lots of chia seeds and flax seeds and other omega 3s, and it's come up a bit, but the rest is not converting, so you have to look at why. Is it a delta-60-desaturase problem? There could be an inborn error of metabolism there.

More likely it's due to inflammatory components in the diet. Then we have the DGLA and the arachidonic. I don't want to spend too much time going over this, but I wanted you to get a sense of what kinds of things you can be looking for.

I want to show you a couple of examples of some fatty acid tests, like the before and after, because this one was dramatic. This was a 60-year-old female. She was suffering when she came in, with depression. She called it bipolar, she'd been diagnosed with bipolar and she also had other issues. I suspected that she had gluten intolerance. We were having a bit of a difficult time convincing her to go off the gluten.

Finally she did the EnteroLab test. She not only did the antibody test, she did the genetics, and found out that she was full-blown celiac. She had all the genes, she had all the inflammation, and she had the gluten antibodies. That convinced her. She went off the gluten, but she still had all this inflammatory stuff going on.

She'd been off the gluten for a while and was improving slowly, but she still had the leaky gut to deal with, and then she had this test done. Let's see what the inflammatory markers are. If you look at this, just to give a head start, AA:EPA which is number nine down here, an ideal ratio there would be 3. She was at 22.

At 22, people are usually having some serious problems like depression, MS, other things that are serious. I said to her, "look, we need to get your fatty acids changed." She was vegan most of the time, but she wasn't that hardcore that she had wanted to stay that way. She was doing a lot of raw foods, and she had made a lot of improvement by this point.

We had a couple of turning point moments here. We looked at the fatty acid test and said "you've got to get to some fatty acids, how do you want to do it? Do you want to do it with the chia seeds and all the other stuff? In which case we can help you, and we can help you with the co-factors." (That was before a lot of the supplement stuff came out with the algae oil) "That's the slow path. Or do you want to do the fast path?"

Now I've said that to other people before and some of them say, "well I don't want to use animal products, I'm ethically vegan and I really don't think it's even good for me as a whole, I really rather stay vegan." I say "fine, here's how we are going to do it. It's going to be slower but here's how we are going to do it."

In her case I put her on pretty large doses of Nordic's natural omegas. If you look at her numbers, her EPA was very low and her DHA was very low, both of them, so I put her on a balanced formula. I think she was taking 2gms or 3gms a day, she took it as a liquid. Voila! Look what happened at the end of four months.

In the meantime she told me she was getting less depressed, her gut was working better, her joints were hurting less, look at where she was in four months. We actually had to take her down a notch because she'd taken too much. This reinforces the importance of retesting because she could have been one of these people who says 'omega 3s, I'm going to take these and she just kept taking them.'

She runs the risks of bleeding disorders. You can get hemorrhagic stroke if your omega levels get too high and your blood gets too thin. We looked at her at four months and her AA:EPA ratio had gone from 22.3 to 1.5. That is on the low side and we wanted it at 3, so all we did was refresh and change things around a little bit, and we changed her situation.

But meanwhile she was feeling better, found some digestive enzymes that worked better for her. It was really after this case that I started really believing in the *Transformation* digestive enzymes as being superior to a lot of other brands because she started on them and it made a huge difference.

She'd been on another brand of enzymes, a good brand (I won't mention the name), and she had been on them for three or four years with making just a little bit of progress, and within three or four months she made huge progress when she started those and she started them independent, that was after this test was done.

That's the kind of stuff that you can see, and that's the importance of testing. We'll go into more detail, I promise you, when we get to the fatty acid module. I'm just giving you a tease and a little head start but just to show you how this other test, which is a *Genova* Full Fatty Acid profile, tests a lot more of the fatty acids.

In addition to alpha-linolenic, the EPA, the DPA, and it tests the DHA, so it gives you the total omega 3s. It also tests more on the linoleic, gamma-linolenic, dihomo-gamma-linolenic, a couple of in-betweens, omega 6s but it also looks at omega 9s, which the other's don't.

And as we go through the rest of this presentation I'm going to give you a little bit of a background of why those omega 9s are important even though they are generally considered not the good fats or the bad fats, they are just the neutral fats.

In fact, depending on what the situation of the person that you are dealing with, nervonic acid as the name implies, is related to the nervous system and it's very important in myelin sheaths and in nerve cell membranes. I'll share with you some of the ways that people can get that fat.

Genova measures some others, which we don't even think about, omega 7s. They give us the saturated fats, and it also shows us the pathway.

The important part about the pathway here is that when we go from the short omegas like the essential ones, the alpha-linolenic and linoleic and we get converted to the gamma, GLA linolenic and down to EPA, we are elongating, we are adding some carbons on to it. The very important enzyme is Delta-60-saturase. We will go into more detail about this enzyme in the inflammation presentation, but suffice to say there are a lot of co-factors including a variety of B vitamins and minerals.

Many people are deficient in these because they eat processed foods, which are devoid of them. In the average American, breads, pastas, puddings, crackers, cakes and pies amount to over 50% of their total food intake.

These have been stripped of the B vitamins, some of the fats, the Vitamin E, and the minerals. We have this deficient population and no wonder everybody is inflamed. You have so much good you can do by helping them to concentrate on fats, not putting them on a low-fat diet, but getting them on an appropriate level of fat that provides them with the building blocks of their nervous system, their immune system, and their endocrine system.

This is a preview of what's to come both in our next video, which we go into a lot more detail on this whose inflammatory pathway, and when we look at case studies. I have hours of recorded case studies where I can share with you, and teach you, some amazing principles in terms of helping your clients.

I'm going to talk about other fats. We've talked about the omega 3s, the omega 6s, and the omega 9s: those are the fatty acids. There are other types of fats that are conglomerates of fatty acids with other molecules. *Triglycerides*, we hear that term a lot, right, 'measure the triglycerides', 'we have high triglycerides', what does it really mean?

*Tri*glycerides is *three—tri*: three fatty acids and one glyceride. On the left you'll see the glyceride molecule and it's bonded to the oxygen on each of the fatty acids. Triglycerides, those fatty acids, could be omega 6s, or omega 3s, or omega 9s, and they could be saturated.

The point is, when your body takes in calories it does not burn, then it's stored as fat. It makes triglycerides. When we measure triglycerides if there's a high level in the bloodstream that's not a good sign.

That's saying that we've got a lot of extra storage forms of energy to put away and it's not being put into the fat. It's floating in the bloodstream where it can wreak havoc in the system.

Whether triglycerides are solid or liquid depends on the fatty acids. Saturated fats are generally solid at room temperature. If you've ever had a jar of coconut oil in the wintertime you have it in your cupboard it's solid as a rock, and if you put it in your refrigerator it's even more solid.

But come summer time when the air gets warmer and the temperature gets above 73 to 75 degrees, that saturated fat becomes more liquid. That's the coconut. Some of the saturated fats in meat and butter and cheese actually have higher temperatures before they become liquid, and some are actually solid at body temperature, which some people theorize contributes to formation of plaque in the body.

I believe the formation of plaque in the body is independent of the amount of fat that you have in the diet if you, indeed, have clean arteries. I think that the buildup of plaque has more to do with the health of artery linings, the health of the endothelium, and whether it's inflamed and damaged.

And guess what? Bad fats damage it. Trans fats are artificially saturated fats. It's when you take a polyunsaturated or a monounsaturated fat, usually polys, and then you put the extra hydrogens in there to saturate it. This causes a break of those double bonds and addition of hydrogens artificially.

It may be sunflower oil that looks like lard because of the extra fat. But it doesn't look like it exactly because the shape changes. You can see when you add an extra double bond you get a change in the shape, you get a bend and you've got the sys form and the trans form. The sys form is naturally occurring in nature, the trans form is not.

When you take in fats that have been artificially hydrogenated, artificially saturated, that change in shape actually causes damage to the blood vessel lining. It's that damage to the blood vessel lining that causes the cholesterol to stick, and then attract metals, and cause plaque, and eventually lead to a heart attack.

We'll go into this in more detail in our Cardiovascular Module. What you will find, as we proceed through our lessons, is that I'm giving you little pieces, so that by the time we get into some of the later modules you can really focus on the particulars there.

I think it's important to understand this because a lot of us go around talking about trans fats, saturated fats and unsaturated fats and omega 3s and 6s without really understanding it.

Then when someone presents some conflicting information or something that's different, you don't know enough about structure to say 'yay' or 'nay'.

Steroids are also fats. Steroids are part of your hormone structures. They are four rings of carbon atoms: three are six-membered and one is five-membered. These four rings that are put together are considered types of fats. Hormones like cholesterol, testosterone, estrogen, progesterone, and DHA, are all steroid hormones.

Vitamin D is really a steroid hormone. It's got that same structure: the four-carbon ring structure at its core. Some alkaloids are steroids. They are found in various herbs which sometimes act as constituents of herbs, but are also found in things like coffee and other things that may not be good for the body.

Corticosteroids are hormones produced from fats, and they are called corticosteroids because they are produced in the adrenal cortex. We'll go into these in our Adrenal Module. Here are some pictures of steroids. You can see three six-carbon rings and one five-carbon ring. They all look very similar: the difference is these little 'side cars' that they have.

What I wanted you to see is, if we look at testosterone next to estradiol for example, or next to progesterone, they have the same core, that same CH3 which is methyl group. The difference is at the far end: testosterone is OH at the end, and progesterone has got another methyl group plus one oxygen.

This is CH_3O, and this is OH; so there's the extra carbon and the extra hydrogen (see *Steroids* slide). That's what makes the difference between progesterone and testosterone, and you know what a big difference functionally that has.

When people think that they can get in there and artificially saturate fats, or make a drug that's similar to progesterone like Provera (which is not really progesterone but it's the patentable form of progesterone), they are fooling themselves if they think they can function the same. I mean look at the difference: that tiny little difference between testosterone and progesterone makes a huge difference in function.

Same things with these guys; just take a look and it's mind boggling to look at the differences between these. So many of them are very, very similar, yet they have very different functions. These are the steroids types of fats.

Sterols are steroids with an alcohol attached at the end. COH in chemistry is an alcohol, OH is an alcohol. They are called steroid alcohols sometimes. You can either have animal sterols or plant sterols. Plant sterols are called *phyto*sterols: *phyto* meaning plant. Animal sterols are called *zoo*sterols: animals live in the *zoo*, study of *zoo*logy.

Cholesterol is actually an animal sterol, and it's the most common and well-known animal sterol. It's vital to animal cell membrane structure and function.

Cholesterol is not the enemy and you are going to see clients who have been brainwashed to think that cholesterol is their enemy. No, it's excessive cholesterol, oxidized cholesterol, and damaged cholesterol that hangs onto the cell walls, which causes a buildup of plaque and causes a problem.

But it's the damage to the cell walls that's problematic. Usually that comes from bad fats, oxidized fats, free radicals, trans fats, and then other things like alcohol and various chemicals and pesticides that damage the vessel linings. We'll learn more about this in the Blood Sugar Module: insulin is damaging to the vessels.

When people eat a lot of sugar and have a lot of insulin in their system, they are causing damage to their vessel walls, which causes the buildup of the cholesterol. This is why diabetes, insulin resistance, and metabolic syndrome, are all types of blood sugar imbalances that are very prone to creating cardiac disease in people.

Ergosterol is found in fungi, which are mushrooms. It's similar to cholesterol but in animal cells. Phytosterols block cholesterol absorption sites in the intestine and help to reduce cholesterol. People who are having problems with high cholesterol already have damage to their vessel linings. They need to bring cholesterol down; we want our cholesterol to be in the right range. We want it to be in that 150-200 range.

When it goes too high, bringing it down can be helpful. There are a lot of reasons it goes too high, and we'll go through those when we get to our Cardiac Module. You will see supplements that contain phytosterols, and these are often used in the management of cardiac disorders.

These are some pictures of various sterols. Here's a picture of cholesterol and you see it looks rather similar in the core to some of the other sterols. Cholesterol is the precursor to the other steroid molecules that we looked at before. Cholesterol has OH, so it's a sterol, a steroid alcohol, and it has other more complicated stuff at the end: some methyl groups and some CH2s and CHs. Those get cleaved away in converting it down to pregnenolone and other steroid hormones.

Here are some other types of sterols: sitosterols, stigmasterol and ergosterol, and these are the plant ones. This is the animal sterol at the top, and these are some of our plant sterols. They are not that much different, but they have quite different functions. These will actually bind to some of the cholesterol sites and interfere with cholesterol, which helps in cardiac problems when people have elevated cholesterols.

Here is an overview of the cholesterol to steroid hormone pathway. We looked at this in our overview module and we'll look at this again when we do sex hormones. We'll be looking at it again when we do adrenals.

Cholesterol sits at the top, it's that sterol, it gets converted to pregnenolone, and then it gets converted down to the various forms, which as we saw, are not that different from each other in terms of molecular structure, but are very different in terms of function. It's amazing how the body works. People will say how it's just a little change in the structure: a little change is a huge change.

Next, we've got *phospholipids*, these are basically fats attached to phosphorus groups. Spingophosphatides (including inositol derivatives) are the backbone of sphingosine, which are the myelin sheaths. This is where some of the fats and the nervous system come into play.

What we have here is the fatty acids, which are at the tail and then we've got those attached to some other groups. In this case there are two fatty acids and those could be a variety of fatty acids, we saw there's a variety of fatty acids in the body, and that's what makes up a lot of the different phospholipids. There's a glycerol group then there's a phosphate group and then there's what is called the polar group, which varies from one of these to another.

When we look at these two different classes of phospholipids (and all the other phospholipids pretty much fall into these classes), the backbone of the spingophosphatides is sphingosine The backbone of the glycerophosphatides is glycerol. The ones that fall into the glycerolphosphatides are the ones we are most familiar with and you may have already heard of.

Lecithin is made up phosphatidylcholine, phosphatidylethanolamine, and phosophatidylinositol. Phosphatidylcholine is easy to get in the diet and you can get that through eating sunflower lecithin and soy lecithin. Lecithin is a component of a food that contains these phospholipids. Phospholipids are very important for membrane fluidity and the passage of things from one part of the cell to another.

Let's look at this in a different way. This is phosphatidylcholine (see *Phosphatidylcholine* slide), this is the generic up here with two fatty acid groups, and here we have two fatty acids, then we have glycerol and then we have the polar group: phosphate and choline. If we had phosphatydal inositol this choline would now be inositol.

If we had phosphatydalserine instead of choline, we would have serine, and each of those has a slightly different function in the body. Phosphatidylcholine is actually a precursor to acetyl choline, which is an important neurotransmitter, important for short-term memory and other things in the brain.

Phosphatydalserine helps to bring cortisol to a stable level, and is often used for people with hyper adrenal when they are in the 'fight or flight' mode, or in stage one adrenal fatigue where the cortisol levels are really high but the DHA is starting to go low. We'll review that when we do adrenals.

What we are doing here is building you a base. Are you going to remember every little bit of this? No. But now when you hear something like 'take phosphatidylcholine it's good for memory' or 'take phosphatydalserine' you'll understand: 'oh phosphatydal they are phospholipids and they have fatty acids in their base, and they have glycerol, and they have phosphates, and they have choline.'

You'll understand what the difference is and you'll learn this through repetition until it starts to make sense when you start to read about these various compounds, and how they are used in helping with balancing specific conditions.

Here again is a list of these phospholipids molecules.

The first one is ethanolamine, the second one is choline, the third one is serine, and the fourth one is inositol. These are phosphatydalethanolamine, phosphatydalcholine, phosphatydalserine, and phosphatydalinositol. They all have the same base: the fatty acids with the glycerol and the phosphate. The difference is what they call the polar molecule, and that would be the inositol, serine, choline, and ethanolamine.

I hope I'm not losing you on this. Another group that I want to talk about is *lipoproteins*. Lipoproteins as the name implies, are lipids combined with proteins and there are a number of them. The reason that lipids get bound to proteins is to allow the lipids to get transported through the bloodstream because, if you remember, water and fat don't mix well.

If you just dump a bunch of fat into the bloodstream it's going to clump into little balls and wouldn't be transported where it needs to go. Lipoproteins are proteins that bind onto a lipid to transport it throughout the bloodstream. Lipoproteins carry cholesterol through the bloodstream.

They carry cholesterol from the liver, where it's made, or from the diet, where it's consumed; and it takes that cholesterol out to the blood vessels. The cholesterol that's been taken to the blood vessels is carried by what's known as a low-density lipoprotein. It's taking cholesterol from the liver and pulling it out to the bloodstream.

Usually, it's because there has been a call that there is inflammation in the bloodstream, and cholesterol is important for that. It also can be because there's a call for making more testosterone or estrogen, and we need to get the cholesterol into the bloodstream so it can then be converted.

LDLs, the low-density lipoproteins, carry the cholesterol out into the bloodstream, and then the high-density lipoproteins (HDLs) carry it out to be excreted. Let's talk about what that really means: *high-density* versus *low-density lipoproteins*. But before we talk about that, let's explain what proteins do with fats: they emulsify the lipid molecules. They make them; they whip them around, so now they can be transported through the bloodstream.

What we find is that many enzymes, structural proteins, antigens, toxins, and transporters of various substances, are all lipoproteins, because that's how we can take fats and move them around the body.

An example, high-density lipoprotein means that it has a lot more protein than lipid. If you think about a lipid it's a low-density molecule. If you put fat into water it floats, it's got a lower density than the water. But if you attach it to protein, and you attach it to a lot of protein, making it a high-density lipoprotein (HDL), it's going to sink because it will have a higher density. Whereas a low-density lipoprotein (LDL) will have more fat and protein. The very low-density lipoprotein (VLDL) has a lot of fat and very little protein. We'll look at a picture.

In this picture we have the core of lipid, the polar surface, and the surrounding protein. In the polar surface envelope, we have apolipoproteins, a free cholesterol, and a phospholipid. It's a very complicated structure. Suffice it to say, it's a combination of fat and protein, including phospholipids, which makes it very important for this transportation of carrying the fat around.

The more protein the higher density, the 'healthier' that lipoprotein is. The good cholesterol is considered HDL, so it's a high-density lipoprotein package of cholesterol, where the cholesterol is within that HDL. The LDL is the low density: here's a picture. We have the high density ones which are a whole lot smaller because they are more compact.

They've got the same amount of protein, they all have the same amount of protein, it's just the HDL has less fat. The LDL gets bigger; it's got more fat. The IDL, the intermediate density (which we don't hear about a whole lot), and the VLDL is even bigger, but it's very low density. Think about the ones that are very low density as the biggest, and the ones that are high density as the smallest.

There are HDL1s and HDL2s; and we'll go into more of this when we do our cardiovascular session and we talk about the VAP test, which measures this. There are ways to measure this in your clients. Right now we are setting the groundwork so that you basically understand. If you want to dig more into this I can do a three-hour lecture just on LDLs, HDLs and VLDLs. You can learn more about them by studying some of the references, or Google searching.

Let's talk about some fatty acids tidbits. These are just little bits of information that I gathered and thought 'this is interesting': it was not something that was in my awareness. Nervonic acid is a long chain omega 9. Remember we said most of them are between 12 and 20 carbons?

This is 24, so it's considered a very long chain fatty acid. And it's an omega 9, meaning if you start at the methyl group, which is down at the bottom here, you count nine and then you have your double bond: so it's an omega 9. We knew that this is the methyl group even though it was cut off in the diagram, because the carboxyl group is at the other end, and because this is the ninth position making it an omega nine. There are ways that you can figure things out.

Remember, nervonic acid is very important to the synthesis of myelin. We talked earlier about the sphingolipids and the spingophosphatides, and the phospholipids that had sphingolipids as part of their matter.

Nervonic acid is an important fatty acid in those sorts of lipids: the phospholipids that are sphingolipids, would have nervonic acid as at least one of those fatty-acid chains.

If we are low in this particular fatty acid there could be a problem with making myelin sheaths. Now there's not a whole lot of research on this, a lot of this is theory. But we are also in the early phases of really, fully understanding MS and other demyelinating diseases.

One of the things you can really chat with your clients about when you are designing diets for them is looking at the sources of some of these fats and making sure that they are included. Fortunately, nervonic acid is included in a lot of the foods that we generally tend to include in a good, healthy diet.

They can be used in the treatment of disorders involving demyelination, adrenoleukodystrophy (ALD), and multiple sclerosis. Those are all problems with the fatty acids. Now when we look at where nervonic acid is coming from we don't really see supplements yet of nervonic acid. The research that I saw, and that I've given references to, is actually talking about that coming, but right now we need to focus on some of the food sources.

Here are some of the food sources of nervonic acid. It looks like king salmon is king, and that's up at the top with 140mg/100g. Yellow mustard seed is pretty high 83 mg/100g, but unless you are a really big fan of mustard it's hard to get a lot of that. Flax seed on the other hand is 64mg/100g, so it's easier to get 64mg of flax seed especially if you go with the flax seed oil: the fatty acid will still be in the oil.

Sockeye salmon, a different type of salmon, is actually much lower than king salmon at 40mg/100g. It's much lower than flax seeds and mustard too. Sesame seeds are close rivals of the sockeye salmon at 35mg/100g. Remember that 100g is about three and a half ounces, so three and a half ounces of sesame seeds is going to be more calorically dense than three and a half ounces of salmon, and it's going to be higher in fat but it is a way to get it. You can start with sesame tahini and sesame oil and things like that.

Macadamia nuts, which are quite yummy, are not as high as the others but they are still considered one of the top sources of nervonic acid at 18mg/100g.

If you are working with somebody and they have a tendency towards, or they've told you they are in a remission state for MS, and they really want to get their health back and prevent that from coming back, including some of these nervonic acid sources on a regular basis, as well as getting rid of all the trans sources. Getting them on the good omega 3s that they need, balancing their fatty acid pathways via the nutrients that are required, whole fresh foods, greens and getting them off gluten and other allergens is going to go a long way.

Adding this piece of nervonic acid to the picture is something that not a lot of people are talking about.

I put it under tidbits because not something that a lot of people are teaching, and I just happened upon it in doing the research and I thought I would share it with you. Oleic acid is one of the most abundant fatty acids in human adipose tissues. Triglycerides are the stored form: a lot of those triglycerides are oleic acid triglycerides.

You can see the shape of it here better than in the picture I had earlier. As I said earlier, generally speaking we don't see straight lines molecules. In nature there are little angles and bends. This shows you the structure of oleic acid. Food sources: olive oil is considered to be the main source with 55-83% of olive oil made of oleic acid. But there are a lot of other good sources as well.

59-75% of pecan oil: people generally don't eat pecan oil, but eating pecans is pretty good, and taking pecan butter and making pecan patties, and using pecan in making salad dressings can give you a good chunk of oleic acid. 61% of canola oil: canola oil is not an oil that I recommend and neither is peanut which is the next one down at 36-67%.

I don't recommend either one of those two oils; canola oil because it's genetically modified and there's really no good unrefined sources of it, I think it's all rancid. And then peanut oil is generally a problem with aflatoxins and it's also one of the only plant foods that's too high in arachidonic acid, which is inflammatory. Canola and peanut I would avoid.

Macadamia nuts: 60% of it is oleic acid and we saw that more of it is nervonic acid, so macadamia is a good food to eat. I've listed these as oils just because that's what the chart lists them as. Personally I think that it's better looking at the whole food. This is says that 60% of the oil is oleic acid, so then the whole macadamia nut is probably 60-75% fat.

There are different ways to calculate the amount of oleic in a particular product. This is to give you a general idea of where it's found. Then it's in lower amounts in chicken and turkey fat, and in lard. High oleic sunflower oil: I don't recommend it either because it's too highly processed even in the high oleic form.

Grape seed oil I don't recommend either; sea buckthorn oil we don't use as cooking oil very often. It's usually used more as therapeutic oil. It's very healthy in the formation of hormones and in women in menopause with vaginal dryness. And sesame oil, remember we saw sesame oil is a good source of nervonic acid as well.

These are foods that are very high in omega 9s, which means that they will not be as high in omega 6s, which means they are not going to throw your omega 6 ratios off as much. Poppyseed oil is not something we use very much, and it's low at 14%. The others are low: like almond has very little oleic, almond is going to be mostly omega 6.

I think that's it for this fatty acid.

It's basically the structure, the function, the biochemistry, the different fatty acids to give you an underlying understanding, so that you really get it when we talk about fatty acids and omega 6s. It's no longer a theoretical concept anymore, like omega 3s are this and that: it's really an understanding of the chemistry.

The next video in this series is going to be about *Fats and Inflammation.* It's going to take you through the fatty acid pathways and the synthesis of prostaglandins, which are inflammatory chemicals. This is good for you to learn and then to be able to teach to your clients on a very simple level.

When they understand this, and what we mean when we are talking about trans fats and the way inflammation affects the blood vessel linings, they will be much more willing to listen to the advice that you give them, and to have better clinical outcomes.

Thanks for listening and here are some references. There are more details on the site, more advanced stuff. There are also some done-for-you resources out there. Check it out and really delve yourself into this and become the master of fats.

Be able to explain to your clients the true roles of fats, that they are not something to be afraid of. They are something to embrace and learn how to make friends with. Teach them the fats that will keep their bodies and their hormones in balance. This is Dr. Ritamarie Loscalzo and we'll see you on the next video.

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