

Feed your genes

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What should we eat? Answers abound in the international media, from Time Magazine to the New York Times Magazine to best-selling authors, all of which rely on their interpretation of recent medical literature to come up with recommendations for the healthiest diet.

But what if you could answer this question at a molecular level – what if you could find out how our genes respond to the foods we eat, and what this does to the cellular processes that make us healthy – or not? That's precisely what biologists at the Norwegian University of Science and Technology (NTNU) have done.

The answer researchers have come up with may surprise you: the best [diet](#), from a gene's standpoint, is one-third protein, one-third fat and one-third carbohydrates. That's what the research shows is the best recipe to limit your risk of most lifestyle-related diseases.

Food affects gene expression

NTNU researchers Ingerid Arbo and Hans-Richard Brattbakk have fed slightly overweight people different diets, and studied the effect of this on [gene expression](#). Gene expression refers to the process where information from a gene's DNA sequence is translated into a substance, like a protein, that is used in a cell's structure or function.

"We have found that a diet with 65 per cent carbohydrates, which often is what the average Norwegian eats in some meals, causes a number of classes of genes to work overtime," says Berit Johansen, a professor of biology at NTNU. She supervises the project's doctoral students and has conducted research on gene expression since the 1990s.

"This affects not only the genes that cause inflammation in the body, which was what we originally wanted to study, but also genes associated with development of cardiovascular disease, some cancers, dementia, and type 2 diabetes -- all the major lifestyle-related diseases," she says.

Common dietary advice and chronic disease

These findings undercut most of the underpinnings for the diets you've heard will save you. Dietary advice abounds, and there is a great deal of variation as to how scientifically justified it is. But it is only now that researchers are figuring out the relationship between diet, digestion and the effect on one's health and immune system – so they can now say not only what kinds of foods are healthiest, but why.

"Both low-carb and high-carb diets are wrong," says Johansen. "But a low-carb diet is closer to the right diet. A healthy diet shouldn't be made up of more than one-third carbohydrates (up to 40 per cent of calories) in each meal, otherwise we stimulate our genes to initiate the activity

that creates inflammation in the body."

This is not the kind of inflammation that you would experience as pain or an illness, but instead it is as if you are battling a chronic light flu-like condition. Your skin is slightly redder, your body stores more water, you feel warmer, and you're not on top mentally. Scientists call this metabolic inflammation.

The body's arms race

Johansen argues that diet is the key to controlling our personal genetic susceptibility to disease. In choosing what we eat, we choose whether we will provide our genes the weapons that cause disease. The immune system operates as if it is the body's surveillance authority and police. When we consume too many carbohydrates and the body is triggered to react, the immune system mobilizes its strength, as if the body were being invaded by bacteria or viruses.

"Genes respond immediately to what they have to work with. It is likely that insulin controls this arms race," Johansen says. "But it's not as simple as the regulation of blood sugar, as many believe. The key lies in insulin's secondary role in a number of other mechanisms. A healthy diet is about eating specific kinds of foods so that that we minimize the body's need to secrete insulin. The secretion of insulin is a defense mechanism in response to too much glucose in the blood, and whether that glucose comes from sugar or from non-sweet carbohydrates such as starches (potatoes, white bread, rice, etc.), doesn't really matter."

Avoid the fat trap!

The professor warns against being caught up in the fat trap. It's simply not good to cut out carbs completely, she says. "The fat/protein trap is

just as bad as the carbohydrate trap. It's about the right balance, as always."

She says we must also make sure to eat carbohydrates, proteins and fats in five to six smaller meals, not just for the main meal, at dinner.

"Eating several small and medium-sized meals throughout the day is important. Don't skip breakfast and don't skip dinner. One-third of every meal should be carbohydrates, one-third protein and one-third fat. That's the recipe for keeping inflammatory and other disease-enhancing genes in check," Johansen explains.

Change is quick

Johansen has some encouraging words, however, for those of us who have been eating a high carbohydrate diet.

"It took just six days to change the gene expression of each of the volunteers," she says, "so it's easy to get started. But if you want to reduce your likelihood of lifestyle disease, this new diet will have to be a permanent change."

Johansen stressed that researchers obviously do not have all the answers to the relationship between diet and food yet. But the trends in the findings, along with recent scientific literature, make it clear that the recommendation should be for people to change their dietary habits.

Otherwise, an increasing number of people will be afflicted with chronic lifestyle diseases.

The new food balance sheet

Most of us think it is fine to have foods that you can either eat or not eat, whether it comes to carbohydrates or fats. So how will we know what to put on our plates?

Do we have to both count calories and weigh our food now?

"Of course you can be that careful," says Johansen. "But you will come a long way just by making some basic choices. If you cut down on boiled root vegetables such as potatoes and carrots, and replace the white bread with a few whole meal slices, such as rye bread, or bake your own crispbread, you will reduce the amount of bad carbohydrates in your diet quite significantly. Furthermore, remember to eat protein and fat at every meal, including breakfast!"

Salad also contains carbohydrates

Johansen explains that many of us do not realize that all the fruits and vegetables we eat also count as carbohydrates – and that it's not just sweet carbohydrates that we should watch out for.

"Salad is made up of carbohydrates," says Johansen. "But you have to eat a lot of greens to get a lot of calories. Steamed broccoli is a great alternative to boiled potatoes. Fruit is good, but you have to be careful not to eat large quantities of the high-glycemic fruits at one time. Variety is important."

The best is to cut down on potatoes, rice and pasta, and to allow ourselves some of the good stuff that has long been in the doghouse in the refrigerator.

"Instead of light products, we should eat real mayonnaise and sour cream," Johansen says, "and have real cream in your sauce, and eat oily fish. That said, we should still remember not to eat too much food, either at each meal or during the day. Fat is twice as calorie-rich as

carbohydrates and proteins, so we have to keep that in mind when planning the sizes of our portions. Fat is also different. We shouldn't eat too much saturated animal fat, but monounsaturated vegetable fats and polyunsaturated marine fats are good."

Spread your calories out

Then there was the issue of six meals a day. Should we eat the same amount at every meal? Is an evening snack OK again? And is breakfast still the most important meal?

"It is better to spread your calories out over the day's meals rather than to cram in a huge dinner," says Johansen. "And both an evening snack and breakfast are good. It is obviously not good to go to sleep when you are stuffed full, but the body needs to refuel after dinner, too. So that means three main meals a day and 2-3 snacks, all balanced."

Johansen explains that one of the main findings of her study was that spreading one's calorie intake out over the day had a beneficial effect on health.

A powdered diet

Johansen and her colleagues conducted two studies. The first was to determine what type of research methods they would use to answer the questions they had. In the pilot study (28 days) five obese men ate real food, while in the second study, 32 slightly overweight men and women (mainly students) ate specially made powdered food.

Participants in the latter study were randomly assigned to go six days on a diet with 65 percent of calories from carbohydrates, with the rest of the calories from protein (15 percent) and fat (20 percent), then a week

with no diet. Then came the six days on a diet with half the carbs and twice as much protein and fat as in the first diet. There were blood tests before and after each dieting period.

The amount of food each person ate was calculated so that their weight would remain stable and so that equal portions were consumed evenly over six meals throughout the day.

The researchers had help developing diets from Fedon Lindberg, a medical doctor who specializes in internal medicine and who promotes low-glycaemic diets, Inge Lindseth, an Oslo dietician who specializes in diabetes, and Ann-Kristin de Soysa, a dietician who works with obese patients at St. Olavs Hospital in Trondheim.

"We wanted to know exactly what the subjects were getting in terms of both macro- and micronutrients," says Johansen, -"A tomato doesn't contain a consistent amount of nutrients, or antioxidants, for example. So make sure we had a handle on the health effects, we had to have accurate accounting of nutrients. That's why we chose the powdered diets for the main study."

Solving the control problem

Diet studies that compare different diets with different amounts of fat are often criticized with the argument that it is difference in the amount of omega-3 fatty acids that causes the health effects, not the rest of the food intake.

The researchers addressed this problem by having the same amount of omega-3 and omega-6 in both diets, although the amount of fat in general was different in the diets that were tested. The researchers also avoided another common problem: the natural variation in gene expression between humans.

"Each of our study subjects was able to be his or her own control person," Johansen says "Every subject was allowed to go on both diets, with a one-week break in between the diets, and half began with one diet, while the rest started with the other diet."

Blood tests were conducted before and after each diet period. All of the measurements of changes in gene expression were done so that each individual's difference in gene expression was compared with that person alone. The results were then compiled.

Johnson says the studies resulted in two important findings. One is the positive effect of many meals throughout the day, and the details about the quality and composition of components in an optimal diet, including omega-3 and omega-6 fatty acids. The second is that a carbohydrate-rich diet, regardless of whether or not a person overeats, has consequences for genes that affect the lifestyle diseases, she says.

A way to measure genetic temperature

Throughout the study, researchers surveyed the extent to which various genes were working normally or overtime. An aggregate measure of the results of all of this genetic activity is called gene expression. It can almost be considered a measurement of the genetic temperature of the body's state of health.

"We are talking about collecting a huge amount of information," says Johansen.

"And it's not like there is a gene for inflammation, for example. So what we look for is whether there are any groups of genes that work overtime. In this study we saw that an entire group of genes that are involved in the development of inflammatory reactions in the body work overtime as a group."

It was not only inflammatory genes that were putting in overtime, as it would turn out. Some clusters of genes that stood out as overactive are linked to the most common lifestyle diseases.

"Genes that are involved in type 2 diabetes, cardiovascular disease, Alzheimer's disease and some forms of cancer respond to diet, and are up-regulated, or activated, by a carbohydrate-rich diet," says Johansen.

Johansen is not a cancer researcher, and is not claiming that it is possible to eliminate your risk of a cancer diagnosis by eating. But she thinks it is worth noting that the genes that we associate with disease risk can be influenced by diet.

"We're not saying that you can prevent or delay the onset of Alzheimer's if you eat right, but it seems sensible to reduce the carbohydrates in our diets," she suggests.

"We need more research on this," Johansen adds. "It seems clear that the composition and quantity of our diets can be key in influencing the symptoms of chronic disease. It is important to distinguish between diet quality and quantity, both clearly have very specific effects."

Fountain-of-youth genes

Some genes are not up-regulated, but rather the opposite – they calm down rather than speed up, Johansen's study shows.

"It was interesting to see the reduction in genetic activity, but we were really happy to see which genes were involved. One set of genes is linked to cardiovascular disease. They were down-regulated in response to a balanced diet, as opposed to a carbohydrate-rich diet," she says. Another gene that was significantly differently expressed by the diets that were tested was one that is commonly called "the youth gene" in the

international research literature.

"We haven't actually stumbled on the fountain of youth here," Johansen laughs, "but we should take these results seriously. The important thing for us is, little by little, we are uncovering the mechanisms of disease progression for many of our major lifestyle-related disorders."

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