Information on a ketogenic (low carbohydrate / high fat + protein) diet for cancer patients

Since 2007, the Dpt. of Obstetrics and Gynaecology, University of Würzburg Hospital has recommended a diet very low in carbohydrates but high in healthy fats and protein for patients with advanced cancer. This kind of diet may also alleviate the side effects of standard chemo- and radiation therapies. We have received several inquiries for information in English and we are happy to offer this now on our homepage. Please find additional information at the bottom of this page.

Before starting this kind of diet

When considering a special diet, please note that the development and spread of cancer is a very complicated and complex process that cannot be fought with diet alone. Nevertheless, cancer cells have a different metabolism than healthy body cells. Tumour tissue prefers sugar for energy and often has problems burning fat for its energy demands. In contrast, the healthy cells of cancer patients often have a problem utilizing carbohydrates and the metabolism favours fat for energy. This phenomenon is predominantly caused by a typical cancer associated metabolism characterized by an increased insulin resistance of muscles and organs and an increased expression of sugar-uptake receptors on cancer cells.

Although none of our patients have suffered any severe side effects on this diet, please inform your oncologist that you are following the diet and ask him/her to support you.

How a ketogenic diet can help cancer patients

A low carbohydrate and high fat diet is called a "**ketogenic diet**" and is used worldwide for the treatment of certain diseases, for example epilepsy in children and adipositas (e. g. Atkins-Diet).

Previously published case studies of tumour patients on a **ketogenic diet** give us reason to hope that this diet can stop the spread of a tumour disease, or at least slow it down (1,2). This diet can also minimize the side effects of chemotherapy (fatigue, exhaustion, stomach pain, and nausea) and prevent weight loss – especially the loss of muscle. A preliminary study at the University of Würzburg Hospital, Dpt. of Obstetrics and Gynaecology (3) has shown the feasibility of this diet for patients with advanced cancer. The effects of this diet on glioblastoma patients are currently being investigated at the University of Frankfurt Hospital, Department of Neurology, within the framework of the ERGO-Study (4). Furthermore, a study protocol on carbohydrate restriction in cancer patients was published by the Hospital of Albert Einstein College of Medicine New York (5).

1) Nebeling LC, Miraldi F, Shurin SB, Lerner E: Effects of a ketogenic diet on tumor metabolism and nutritional status in pediatric oncology patients: two case reports. J Am Coll Nutr. 1995 Apr;14 (2):202-8.

2) Nebeling LC, Lerner E. :Implementing a ketogenic diet based on medium-chain triglyceride oil in pediatric patients with cancer. J Am Diet Assoc. 1995 Jun;95(6):693-7. Review. PubMed PMID: 7759747.

3) Schmidt M, Pfetzer N, Strauss I, Coy J, Schmidt A, Dietl J, Kammerer U.: A ketogenic diet improves quality of life in some patients with advanced metastatic tumours. Anticancer Research (supplement) in press

4) ERGO-study http://www.kgu.de/neuroonkologie/html/ergo-studie.html

5) Fine EJ et al., Carbohydrate restriction in patients with advanced cancer: a protocol to assess safety and feasibility with an accompanying hypothesis. Community Oncology. January 2008

Additional information

The **booklet** "**Ketogenic Diet and Cancer"** includes scientific findings, an outline of the diet, recommendations, tips on changing your diet, tables, and links for further information and recipes.

Booklet engl

The **brochure „Food Facts"** will help you calculate the carbohydrates in your food.

Food facts engl.

We are currently preparing a recipe booklet for bread, pasta cakes, cookies, etc. in English. The German version is available here.

Webmaster

Seite aktualisiert am: 29.10.09

Universitätsklinikum Würzburg
Klinikum der Bayerischen Julius-Maximilians-Universität
Frauenklinik und Poliklinik
Direktor: Prof. Dr. med. Johannes Dietl

A low carbohydrate, high fat/protein (ketogenic) Diet for Cancer Patients

Dear Patient

The food we eat has always stood in direct relationship to the development of diseases and cancer. Certain foods and diets are considered harmful, others healthy. There are a lot of different findings and preconceptions on this topic. In general though, everyone should eat a healthy, low toxic diet based on natural food.

Many cancer patients want to know what they can do to improve their health, and making healthy changes in their diet is an important step. There have been many diet recommendations for cancer patients over the past decades and you may be asking yourself if this is just another diet promising improvement, or even a cure. We know that the development and spread of cancer is a very complicated and complex process that cannot be fought with diet alone. Nevertheless, cancer cells have a different metabolism than healthy body cells. Tumour tissue prefers sugar for energy and produces its own fatty acids. In contrast, cancer patients often have a problem utilizing carbohydrates and their metabolism favours fat for energy. We would like to show you a diet that reduces the tumour its sugar supply, the carbohydrates, while providing the body with enough energy in the form of fat and protein. A low carbohydrate and high fat diet is called a "**ketogenic diet**" and is used worldwide for the treatment of certain diseases, for example epilepsy in children.

Case studies of tumour patients on a **ketogenic diet** give us reason to hope that this diet can stop the spread of a tumour disease, or at least slow it down. This diet can minimize the side effects of chemotherapy (fatigue, exhaustion, stomach pain, and nausea) as well as preventing weight loss – especially the loss of muscle. The feasibility and

effectiveness of this diet are presently being studied at the University of Würzburg Hospital for Gynaecology and within the framework of the ERGO-Study at the University of Frankfurt Hospital, Department of Neurology.

This booklet will begin with the scientific findings on this **ketogenic diet and cancer**, followed by an outline of the diet, recommendations, tips on changing your diet, tables, and how to get further information and recipes.

Dr. U. Kämmerer
Scientific Head

We highly appreciate the amazing translation of the brochure by Lorraine Stevenson-Knebel (University of Würzburg Hospital, Department of Surgery I, Experimental Transplantation Immunology)

For further information:
http://www.frauenklinik.uni-wuerzburg.de/forschung/ketogenic_english.htm

Carbohydrate Metabolism

Glucose is the main fuel for producing energy in our cells. Sufficient oxygen is also essential for the cellular respiration in the cell **"**powerhouses**"**, the mitochondria. The brain, especially, usually converts only sugar to energy. The body produces glucose in the digestion tract from practically all available carbohydrates (starch and sugar, for example).

Glucose is a sugar component found in cane sugar and milk sugar (lactose). Granulated sugar is the main ingredient in sweets, sweet baked goods, soft drinks, and fruit juices. Glucose is also the basis of complex carbohydrates (polysaccharides), such as starches. All these sugars belong to the group of carbohydrates. Fibers are also carbohydrates, but because our bodies are unable to utilize them we must distinguish between the "usable" carbohydrates and fibers.

Many basic foods and almost all fast food and convenience foods contain a high amount of carbohydrates that quickly release glucose during digestion. Bread, pasta, rice, potatoes, pizza, burgers, sweet baked goods and almost all fruits belong to this group. The glucose released during digestion is absorbed over the intestine and quickly transferred to the blood stream. The hormone **insulin** is now necessary to push glucose into the cells. The pancreas pumps out insulin as soon as we eat sugar and other carbohydrates. This insulin allows the cells to absorb glucose from the blood stream, normalizing the blood sugar level. This mechanism prevents an excess of sugar in the blood stream (hyperglycaemia) and the resulting damage. Insulin helps to turn the

extra sugar into **glycogen**, which is stored in the liver and muscle tissue, but some of it is also turned into fat.

If the blood sugar level sinks below a certain level, the hormone **glucagon** is released. This triggers the release of glucose from the glycogen depots into the blood stream while at the same time producing new glucose from the amino acids, part of the proteins. This mechanism guarantees a relatively constant glucose concentration in the blood stream.

During a fasting period, for example, most healthy cells are able to change to fat and protein for their energy production so that they need only few carbohydrates, if any. The liver can produce the small amount of glucose needed for vital metabolism processes from its amino acids. This means that it is possible to follow a diet containing almost no carbohydrates, as long as enough protein and fat are consumed. The blood sugar level is thus, kept at a constant healthy level. Because oils and fats cannot produce glucose, they immediately serve as energy sources for the fat burning process.

Fat (Lipid) Metabolism and Ketones

When the usual high carbohydrate western diet is suddenly changed to a diet extremely low in carbohydrates, the body starts burning fat. Almost all cells, except those of the brain, can get their energy by burning fatty acids. The brain, which depends on a continuous supply of glucose, will still need it at the start of the ketogenic diet and will get its glucose from the liver where sugar is produced from protein. The body will greatly increase its production of ketones shortly after it starts burning more fat. Ketones are produced in the liver from acetyl-CoA, which forms during the breakdown of fatty acids. Almost all body cells can use these ketones for energy. After an adjustment period of 2 – 5 days, the brain can also use these ketones for up to 80% of its energy needs. Excess ketones cannot be stored in the body and are discarded with the urine. Their presence can be monitored with test strips. Excess ketones will also be released over the breath, causing the breath to smell like acetone. **The term ketogenic diet means a diet form that produces ketones which are traceable in urine**. This metabolism change to fat and ketone use is a normal process that ensures survival during any fasting period. This physiological ketosis should not be confused with the ketoacidosis, a life threatening complication of diabetes following severe hyperglycaemia. A light ketosis, in which ketones provide energy for the brain, is a fully normal, harmless process that has occurred over millions of years whenever few carbohydrates were available.

The Sugar Metabolism of Tumours

The sugar metabolism of cancer cells and their giant appetite for sugar is repeatedly mentioned in scientific literature as something extraordinary.

This goes back to an observation the German Nobel Prize winner Otto Warburg made over 80 years ago: unlike healthy cells, many cancer cells cannot get their energy predominantly from cell respiration and fat breakdown. They are dependent on sugar fermentation. The generation of energy through fermentation is not the cause of cancer, but probably a result of the oxygen shortage cancer cells suffer during growth, genetic changes, and typical cancer defects in the mitochondria. Cancer cells are dependent on a regular supply of sugar because fermentation requires large amounts of glucose. If we could deprive the cancer cells of this sugar entirely, they would have a hard time getting the energy they need to grow.

There are several techniques to monitor the fermentation of glucose in tumour cells. A positron emission tomography (PET) can make the high sugar consumption of tumours visible. The patients are injected with a radioactive glucose tracer and a special machine then shows the concentration of sugar in the tumour cells. Lactic acid, a by-product of fermentation, can be detected in the blood or with a so called 1H-MR spectroscopy in a specialized MR scanner when large tumours are present. If tumour tissue is available for histological tests certain factors typical to the altered sugar metabolism can be detected with special antibodies.

Sugar Metabolism and Tumour Growth

The changes brought on by the fermentation of glucose for energy have certain advantages for tumour cells:

- Lactic acid, produced during sugar fermentation, destroys healthy neighbouring cells. This makes it easier for tumour cells to enter healthy tissue and build metastases. Lactic acid also inhibits immune cells from attacking tumours.

- The mitochondria, the cell “powerhouses” are not involved in sugar fermentation in the cells. However, many chemotherapeutics and radiotherapy attack the mitochondria, and once destroyed these cells become resistant to many chemotherapies and radiotherapies.

- A lot of oxygen is needed for cell respiration, fermentation doesn’t need any. Tumour cells that ferment glucose are no longer dependent on a sufficient supply of oxygen; they can grow without it.

However, the changes in metabolism also have a few disadvantages for tumour cells:

- Tumour cells are dependent on a high supply of glucose because only glucose supplies energy for fermentation. Tumour cells need a lot more glucose than normal cells.

- Fermenting tumour cells often have a problem burning fat. This means that they cannot use oils or fat for energy, or only a small amount.

The weak point, the “Achilles heel”, of many tumour cells is their dependence on glucose and their inability to use oils or fat for energy. This is the ideal starting point for a tumour therapy. Substances that directly inhibit sugar fermentation in tumours would prevent them from growing, while normal cells could switch to other energy sources. Such substances are presently being developed and tested, but are not yet available for therapy. Presently, the only available therapy is changing to a diet that denies tumour cells sugar while providing healthy cells with sufficient energy.

The Ketogenic Diet

We would like to explain the concept of the ketogenic diet to you and give you some tips on changing your diet. Not all of the diet guidelines follow recommendations from dietary experts. Certain signs of deficiencies and constipation may develop when mistakes are made following the diet, but this is rare. It is very important to follow the diet carefully and drink at least 2 – 3 litres (carbohydrate free liquids) a day. A physician should supervise your diet, ideally in a study.

The Basis of the Ketogenic Diet

As already explained, a diet with almost no glucose or carbohydrates and a high ratio of oils, fat, and protein still has enough glucose from proteins to maintain a constant blood sugar level. When the level of glucose or carbohydrates drops below 50 grams a day, most healthy cells start burning fatty acids and **ketones**. The main energy supply is then no longer glucose, but fatty acids and ketones. Our nerve cells, including the brain, can change to ketones for most of their needs. Eskimos and Maasai have always lead healthy lives on a traditional diet of fish, meat, and milk, and almost no carbohydrates.

Tests done on people that follow a low carb, ketogenic diet have shown that the diet actually can lower the blood sugar level and raise the levels of ketone bodies. A low carb diet is especially effective in preventing the blood glucose peaks that occur after a high carbohydrate meal. Case studies on cancer patients have shown that a ketogenic diet can improve their quality of life and possibly even slow down the spread of the disease.

With this **low carb, high fat/protein diet** your body will adapt to using fatty acids and ketones for energy. The sugar that the liver provides and the natural sugar in fruit and dairy products, for example, are sufficient for the body's needs.

Changing to a ketogenic diet can have a significant influence on the glucose supply to tumour cells, even in patients with a healthy, constant blood glucose level.

An important advantage of a **low carb, high fat/protein diet** is that it prevents surges in the blood sugar level. This means that hardly any insulin is released. Insulin not only helps to transport sugar into the cells, but it also helps many tumours grow. A low insulin level means less growth stimulation for these tumour cells.

Choosing the Right Fats for the Low Carbohydrate, High Fat/Protein Diet

Many recent studies have shown that omega-3 fatty acids inhibit tumours. This is why it is very important to choose oils especially rich in omega-3 fatty acids, such as linseed, hempseed, and fish oil. Oils rich in Omega-6 fatty acids, such as sunflower seed oil, soya oil, safflower oil and grain seed oils should be avoided because they can cause inflammation, suppress natural immune responses and perhaps even support the growth of tumour cells (orange table, page 24). Medium-chain triglycerides (MCT) can be absorbed by the body without using any energy. Several studies have shown that they inhibit tumour cell growth and have a positive effect on body weight. They should be first choice in this diet.

The Ketogenic Diet Therapy for Tumour Cachexia

Chemotherapy is often accompanied by loss of appetite, liver and digestion disorders, and vomiting. A rapid **weight loss** can be the result. This is also known as **tumour cachexia**. Drastic weight loss is also caused by the change in metabolism and the extreme sugar appetite of many tumour cells. If there are not enough carbohydrates in the diet to satisfy this sugar appetite, the liver must constantly draw on the body's protein to produce new sugar. Metabolizing protein means muscle will be destroyed. The tumour doesn't burn all that glucose; it is fermented. This fermentation results in great amounts of lactic acid waste which leads to a high acidification of the body and health problems. To prevent this, the liver must use its energy reserves to change lactic acid to glucose. The hungry tumour cells crave this glucose and the vicious circle continues.

A **low carbohydrate, high fat/protein diet** can counteract this. The diet supplies healthy cells with fat and ketones for energy, and the liver also gets enough energy and protein for its work. This protects the muscles from breakdown. Body builders, for example, often follow a low carbohydrate diet to build up muscle. **Medium-chain triglycerides (MCT)** satisfy the enormous energy needs of a body with advanced cancer, but only low concentrations of MCT, mainly in milk fat, are found in our daily diet. MCT oil is usually made from palm oil and coconut oil. It can be easily absorbed through the intestine to provide energy. The MCT are channelled directly to the mitochondria where they are burned. Studies have shown a definite anti-cachectic effect of the MCT diet. Patients have a greater quality of life when weight and energy loss can

be prevented, even though they have to give up their dear sweets and beer.

Tumours and Sport

The influence of physical activity and sport on the development of malignant diseases has been a topic of research since many years. Studies released 20 years ago showed that active people have a lower risk of developing cancer. This has been confirmed in many studies since then. At the end of 2002 the American “Journal of Nutrition” published a list of 170 studies that all showed a lower risk of cancer for active people.

Physical activity also has a positive influence on the blood sugar level. More glucose is needed for sport, which empties the glycogen deposits and keeps the blood sugar level low. **Sport and a ketogenic diet go hand in hand**.

If your health allows, we recommend that you choose a physical activity you can enjoy. The emphasis should be on a constant, consistent activity such as bike riding, fitness walking, and jogging rather than something that involves short bursts of high intensity. Long, normal walks are also a good choice.

Recommendations for Changing your Diet

It is quite easy to **change to a ketogenic diet** with normal foods. You must choose your foods carefully though, and some foods will only be available in health food stores and by mail order. It is also necessary that you study the basics of the diet to prevent vitamin and mineral deficiencies. You should enjoy cooking and baking, or have someone who will do this for you. We will provide you with some tips on getting started and you will find a list of foods you can eat in the appendix.

The most important aspect of the ketogenic diet is the strict reduction of glucose/carbohydrates (max. 50 grams of carbohydrates daily), a strong increase in healthy fats, and a well-balanced protein supply.

The biggest change is probably with your high carbohydrate, filling side dishes such as potatoes, rice (rice cakes, too), pasta, milo, corn, semolina, unripe spelt grains, and chickpeas, as well as all cereals and grain flours (bread, cookies, and cake). These must be replaced with low carbohydrate alternatives.

If you really cannot imagine eating your cold cuts and meats without bread, you will find some recipes for carbohydrate reduced breads in the appendix. There are also several low carb (LC) websites on the internet where you can find recipes and addresses for ordering low carbohydrate bread and cake mixes as well as special ingredients such as gluten and nut flours. Some bakeries have low carbohydrate bread that is usually made of almond flour. Butter is the ideal spread; margarine contains not

only unhealthy saturated fatty acids but often several additives. Special low carbohydrate fruit spreads are available in natural food stores, but should only be used sparingly.

High quality, cold-pressed vegetable oils are especially important in the ketogenic diet. They will provide you with many essential fatty acids, (especially omega-3 fatty acids) and fat-soluble vitamins (important: vitamin D). These include high quality hempseed, flaxseed, rapeseed, and fish oils, especially. These oils should be stored air tight and not heated. Use them in salad dressings or add them to your curd cheese and other dairy products. You should consume at least 4 – 6 grams of omega-3 fatty acids daily. This is equal to 4 -6 capsules of a supplement containing 1000 mg per capsule. Better – and cheaper – is fresh (!) linseed oil, for example. Linseed oil has 55 grams of omega-3 fatty acids in 100 ml, so that you would only need 1 tablespoon (10 ml) a day. You can, of course, take more oil. Unfortunately, once a bottle of oil is opened, the omega-3 fatty acids quickly diminish. To ensure an adequate intake you should take 4 – 6 tablespoons of different high quality oils daily – ideally together with proteins. Don't worry about too many calories! Patients who need to regain weight and those who want to prevent weight loss should take MCT oils in addition to vegetable oils. A good mix is ¾ vegetable oils and ¼ MCT oils. MCT oils are pure energy for the body. Suppliers can be found on the internet (keyword "MCT oil", addresses in the appendix).

It is very important to ensure that the dairy products you buy are low in milk sugar. This is the case for yogurt, curdled milk, and especially curd cheese. Low fat milk and milk products usually contain quite a lot of milk

sugar or added sugar; the products with a normal fat content are the better choice. Always read the package information carefully! Curd cheese, especially the full fat varieties, can be spiced up and seasoned with herbs. You can create a delicious sweet dessert or breakfast by adding fresh fruit, berries, or nuts.

Choose full fat cheeses and aged alpine cheeses. These are especially low in carbohydrates, and because the animals feed on pastures, rich in omega-3 fatty acids and vitamin D. Goat and sheep cheese, as well as full fat cream cheeses are good choices on this diet. You can eat as much low carb cheese as you want. Please take into account the carbohydrates in soy products (tofu). Soy is a good source of protein, especially if you don't eat much meat.

When shopping for meat and cold cuts, be aware that the way an animal lives will influence the quality and taste of its meat. The meat of game and animals out on pasture that are not fed grains has a lot more omega-3 fatty acids than other animal meat. Whenever possible, buy high quality meat from free range animals or animals fed on organic feed. Almost all cold cuts and salami contain up to 1% added sugar to improve the taste. Read the food information labels carefully or ask your butcher about carbohydrate additives. **Sugar is often hidden in names such as dextrose, maltose, galactose, fructose, sucrose, saccharose, etc.** Fatty cold water fish such as herring, sardines, mackerel, and salmon (but not those from fish farms that are fed grains) are very rich in omega-3 fatty acids. You can eat all sorts of meat and fish (but not breaded) on a ketogenic diet. We recommend rapeseed or olive oil, palm oil or coconut oil for frying.

Nuts (walnuts, brazil nuts, macadamia nuts) and oil seeds (linseeds, hempseeds, sunflower seeds, sesame seeds, etc.) should be added to your diet because they are very rich in high quality fatty acids. Please note that cashews are not “nuts” and are high in carbohydrates Linseeds and hempseeds, especially, are rich in omega-3 fatty acids. They are best taken freshly ground on curd cheese or salads, for example. Hempseeds and hemp oils can be found in natural food stores and on the internet.

Green vegetables (broccoli, spinach, asparagus, zucchini, cucumbers, cabbage, and green beans), tomatoes, raw carrots, peppers that aren’t too sweet, and all kinds of lettuce are ideal partners for fish and meat. Starchy vegetables such as cooked carrots, peas, beans, lentils, and corn could cause a significant increase in your blood sugar level, and therefore, should be avoided. Please try and stick to the vegetables in the green list.

Fruit, although delicious and full of vitamins, must be avoided because it usually contains too much glucose and fructose. Berries, on the other hand, are especially valuable because they are not only low carb, but might also have cancer-inhibiting properties. Eat small amounts of fruit and berries and keep track of the carbohydrates (max. 6 grams per portion). Calorie tables and the yellow list in the appendix will help you. Canned fruit should be avoided because it has fewer vitamins and is often sweetened, but frozen, unsweetened fruits are a good choice. Raisins, all kinds of dried fruits, and smoothies should be avoided because the fruit sugar is highly concentrated.

If you love chocolate and don't want to give it up entirely, you might enjoy a small square of very dark, unfilled chocolate once in a while with a cocoa content of at least 80% and less than 30% carbohydrates.

It is very important to make sure you **drink enough** to prevent kidney stones and to flush ketones out of your body. Try to drink at least 2 – 3 litres a day, preferably water, herbal teas and green tea (unsweetened or artificial sweetener). Several studies have shown that green tea has distinct cancer-inhibiting properties. Ideally you should drink six cups of green tea (steeped for 10 min.) every day. Coffee should be taken with cream and not milk (because of the milk sugar). If you like drinking fruit juices with mineral water be sure to mix 1 part juice with 9 parts water and calculate the carbohydrates. Choose 100% pure juices and not fruit drinks. Soft drinks, ice teas, and lemonades are not allowed. Beer must also be avoided because it is extremely high in carbohydrates. You may enjoy a glass of red wine once in a while. Red wine contains phytochemicals that are good for you and your cells. Milk and milk drinks should be avoided because of the milk sugar and added sweeteners.

The ketogenic diet presented here is not about losing weight, but about changing the body's metabolism and perhaps preventing tumour cachexia. Because the filling side dishes of a normal diet are missing here, you must increase your servings of oils, meat, fish, soy products, and cheese. If you want to gain weight, increase the oil in salads and other cold foods and add MCT. If you want to lose weight, keep your oil consumption to 4 tablespoons a day and try to maintain your normal servings of meat and fish. Lots of salads dressed up with oil, salt, pepper, herbs, and different vinegars, nuts (perhaps roasted) and ground

oil seeds (linseed, hempseed), and lots of vegetables from the green list will keep you from feeling hungry and prevent constipation.

Internet Suppliers of Low Carbohydrate (LC) Products and Websites for Recipes

You will easily find further general information, cooking recipes and suppliers for LC products if you search the internet with the following phrases:
„Low Carb“, “Low Carb Diet”, “Atkins Diet”, “Low Carb – high fat”, “Ketogenic diet”

Please note: These are just a few suggestions on where to get more information. We are not responsible for the content of the websites and have no financial interests.

For Calculating Carbohydrates:

Check the nutrition panels on the labels of food packages an search for “nutritional panel calculator” in the internet or by a book with the most common food listened.

Following, you will find tables with information on the foods for your diet.

Green List:	ideal choices because few or no carbohydrates
Yellow List:	Important foods for the diet with information on their carbohydrate content
Orange list:	Vegetable oils and nutritional information

Green List: Eat as you wish. Only count the carbohydrates of vegetables if you eat lots of one kind.

Meat: beef lamb pork veal **Game:** deer hare (jack rabbit) rabbit wild boar	**Fish:** carp codfish eel haddock halibut herring mackerel pollack redfish sardine salmon shark sole trout tuna zander	**Vegetables:** asparagus avocado broccoli brussel sprouts cabbage cauliflower celery chicory chinese lettuce cress cucumbers egg plant fennel green beans green cabbage kohlrabi mangold onions parsley porree radishes red cabbage sauerkraut savoy cabbage spinach tomatoes zucchini **see yellow list**	**Lettuce:** butterhead chicory endive iceberg lamb's lettuce lollo rosa rocket romaine watercress *etc.*
Cold cuts: cooked ham raw ham(dry cured) cold cuts and salami (without added sugar/carbs)			**Mushrooms:** all wild mushrooms boletus chanterelle shiitake white mushrooms
Poultry: chicken duck goose ostrich turkey	**Shellfish:** prawns/shrimps lobster crabmeat		**Nuts and Seeds:** brazil nuts hemp nut seeds linseeds macadamia nuts **see yellow list**
Dairy products: cream sour cream **see yellow list**	**Mollusks:** octopus, natural oysters mussels		
Cheese: alpine cheese camembert (full fat) Edam/Gouda Emmentaler German Hand Cheese goat's cheese Mozzarella Parmesan Roquefort sheep's cheese	**Eggs:** chicken eggs	**Fats and Oils:** animal fats argan oil butter hempseed oil grape seed oil linseed oil olive oil pumpkin seed oil rapeseed oil walnut oil etc.	**Fruit:** **see yellow list** olives

Yellow List: Count the Carbohydrates!

Blue: highly recommended, because low carb and/or possible positive effects on cancer

Fruit	g Carbohydrates in 100 g Fruit
acerola (barbados cherries)	**3**
apple	12
apricot	8
banana	16
black currant berries	12
blueberries	**7**
cherries, sweet	13
clementine	9
cranberries	7
elderberries	7.4
gooseberries	7
grapefruit	7
grapes	16
honeydew melon	5.3
kiwi	10.7
lemon	**5**
mandarine	10
mango	11
mulberries	**2.7**
nectarine	16
orange/mandarine	9
papaya	**7**
passionfruit	13
peach	8
pear	13
persimmon berries	17
pineapple	7
plums	14
pomegranate	9
raspberries	**4.8**
red currant berries	**7.3**
rhubarb, fresh	**1.4**
small yellow plums	15
strawberries	**5.5**
watermelon	8

Dairy Products	g Carbohydrates in 100 g
cream cheese (65 - 85% fat)	3
curd cheese (40% fat)	**2.6**
curd cheese, low fat	3.2
jogurt (natural, 3,5% fat)	5
whey (sweet)	4.7

Nuts / Seeds	g Carbohydrates in 100 g
almonds	**3.7**
brazil nuts	**3.5**
cashew nuts	30.5
coconut	**5**
hazel nuts	11.4
peanuts	8.3
pecan nuts	**4.4**
pine nuts	20.5
pistachios	17.5
pumpkin seeds	14.2
sesame seeds	10.2
sunflower seeds (without shell)	12
walnuts	10

Vegetables	g Carbohydrates in 100 g
beans (kidney, white)	9
beets (raw)	8.4
carrots, fresh	4.8
corn (kernels)	15.7
peas (without pod)	12.5
potato (cooked, with peel)	15
pumpkin	5

Orange List: the most important oils and their fatty acids

Oil * *in % of weight*	**saturated fatty acids** (%)*	**mono-unsaturated fatty acids**(%)*	**polyunsatures** (%)*	linoleic acid **Omega-6** (%)*	alpha-linolenic acid **Omega-3** (%)*	**vitamin E** (mg/100g)*	Ratio Omega 3 : Omega 6 *	gamma-linolenic acid
Argan oil	18.0	47.0	35.0	36.8	0.3		1:122	
Borage oil				45	**22**	?	**1:2**	24
Coconut oil	90.5	7	2.5	1.4	-	1	-	
Evening primrose oil				72	4	?		14
Fish oil	32	22	46		**35**	4		
Grape seed oil	10.5	19	70.5	65.9	0.5	30	1:132	
Hemp oil	10	15	**75**	58	20	12	**1:2,9**	3
Linseed oil	9	18	**73**	13.9	**54.2**	5.8	**4:1**	-
Maize germ oil	14.5	32.5	53	55.3	0.9	30	1:61,4	
Olive oil	15.5	74	10.5	8.3	0.9	12	1:9,2	-
Palm oil	51.5	38	10.5	10.1	0.5	-	1:20	
Peanut oil	19.8	55.6	22.2	23.9	0.3	17,2	1:77	
Pumpkin seed oil	19.2	28	52.8	49.4	0.5	~50	1:99	
Rapeseed oil (Canola)	13	56	31	22.3	9.2		**1:2,4**	-
Sesame seed oil	13.5	42	44.5	42.7	0.0	4	-	
Soya oil	15	21	64	53.1	7.7	15	1: 6,9	
Sunflower seed oil	12	24	64	63.0	0.5	55	1:126	-
Thistle oil	9	13	**78**	75.1	0.5	35	1:150	-
Walnut oil	8	20	**72**	55.1	12.9	3	1:4,3	
Wheat germ oil	16	22	62	55.7	7.8	**215**	1:7	

- *The ratio of Omega-3 to Omega-6 should not be greater than **1:5**.*
- *Feel free to mix the oils, but only small portions and as fresh as possible to preserve the valuable fatty acids! Adding vitamin E (from supplement capsules), 400 mg/ 100 ml oil will prevent oxidation and loss of omega-3 fatty acids*

Recipes for baked goods (bread, cakes), sweets and desserts suitable for the ketogenic diet

We have created lots of recipes for breads, cakes, tarts, muffins, pasta, pizza, and desserts that can be made with normal ingredients. You will find these recipes in an additional brochure on the internet, however, unfortunately at present available as German version only:

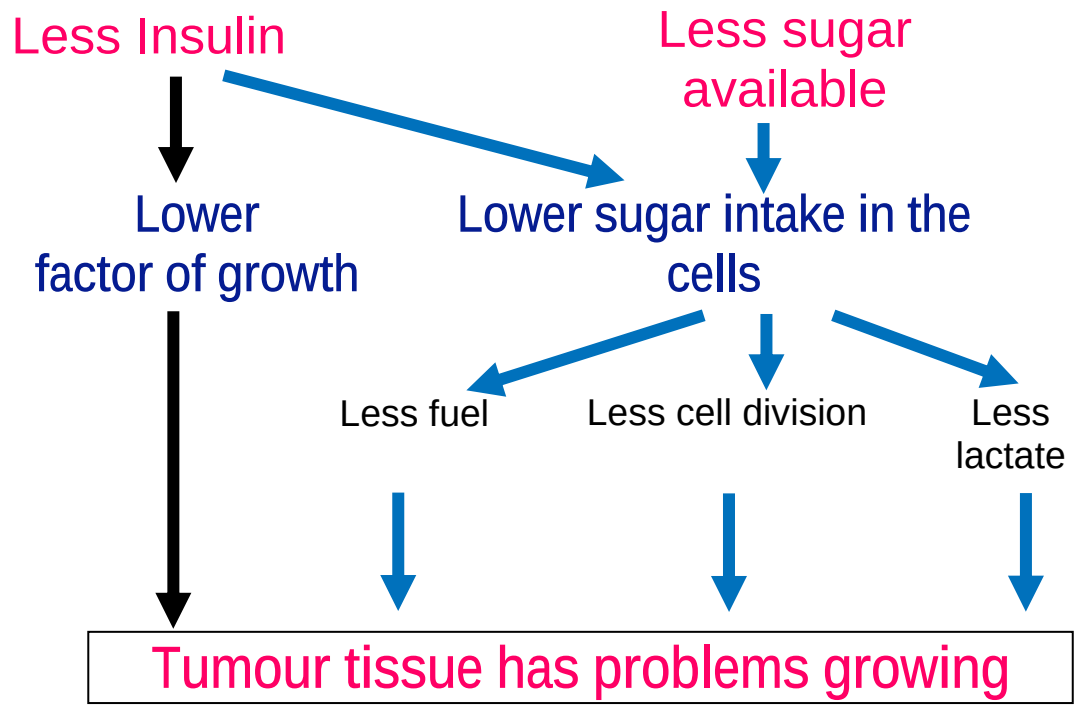
http://www.frauenklinik.uni-wuerzburg.de/forschung/ketogenic_english.htm

Based on the information currently available, we hope that by following the low carbohydrate, high fat/protein ketogenic diet:

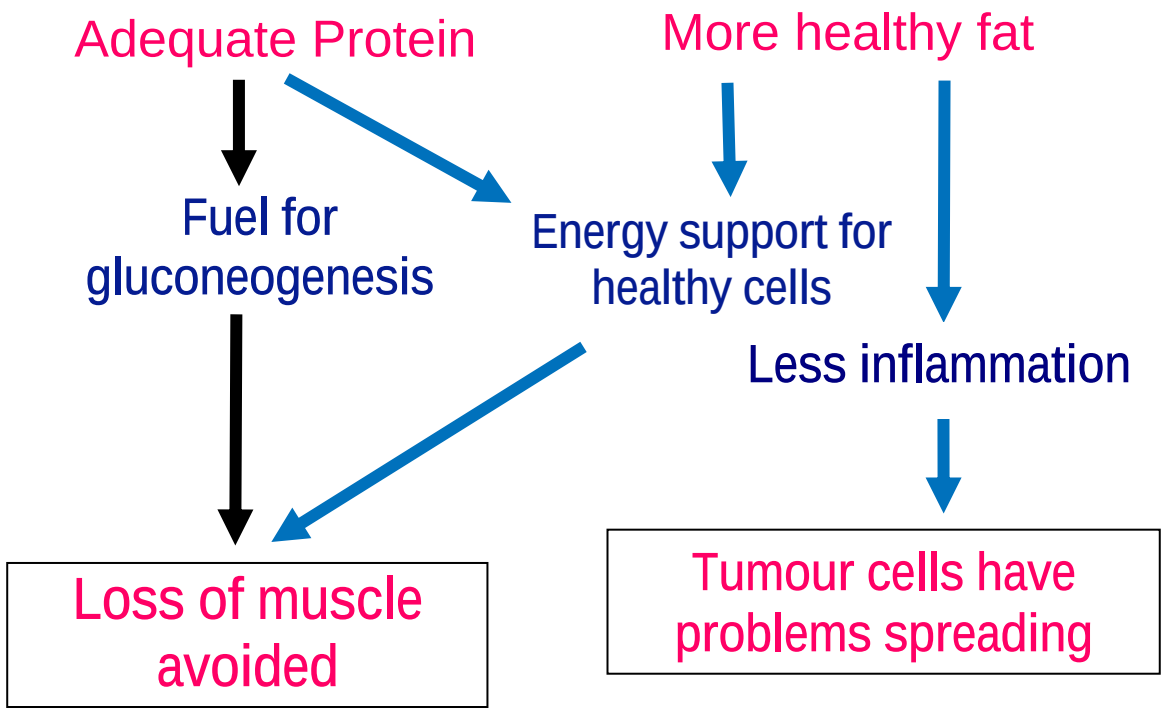
- the growth of cancerous tumours and metastases will be slowed down,
- chemotherapies will be more effective,
- radiation therapies will be more effective,
- the overall quality of life will improve, and
- a longer survival is possible,

although we can't give any guarantees.

1st Hypothesis of the diet: Few Carbohydrates



2nd Hypothesis of the diet: More healthy fat and protein



Literature:

Kroemer G, Pouyssegur J.
Tumor cell metabolism: cancer's Achilles' heel. Cancer Cell. 2008 Jun;13(6):472-82.

Gillies RJ, Gatenby RA.
Adaptive landscapes and emergent phenotypes: why do cancers have high glycolysis? J Bioenerg Biomembr. 2007 Jun;39(3):251-7.

Deberardinis RJ, Sayed N, Ditsworth D, Thompson CB.
Brick by brick: metabolism and tumor cell growth. Curr Opin Genet Dev. 2008 Feb;18(1):54-61.

Young CD, Anderson SM.
Sugar and fat - that's where it's at: metabolic changes in tumors. Breast Cancer Res. 2008;10(1):202.

Shaw RJ.
Glucose metabolism and cancer. Curr Opin Cell Biol. 2006 Dec;18(6):598-608.

Kim JW, Dang CV.
Cancer's molecular sweet tooth and the Warburg effect. Cancer Res. 2006 Sep 15;66(18):8927-30.

http://www.frauenklinik.uni-wuerzburg.de/forschung/ketogenic_english.htm