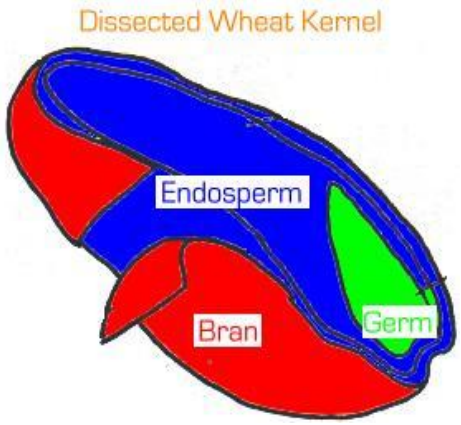
Dietary Fiber Primer

The main part of the **wheat** kernel is the starchy **endosperm**, which comprises more than 80 percent of the kernel weight and is the part of the kernel that eventually will be milled to wheat flour. **Wheat bran** is the papery brown coating of a whole grain of wheat. Removed during milling, wheat bran is sold packaged and in bulk. A quarter cup provides 6 g fiber. **Wheat germ** is the embryo of the wheat kernel. It is removed during the milling of white flour but is left intact in whole-wheat varieties. Wheat germ is sold raw or lightly toasted.



Fiber

1) increases satiety rate,

2) reduces nutrient bioavailability,

3) reduces energy density,

4) alters hormonal response and

5) alters thermogenesis in obesity.

The mechanisms seem to be that fiber

1) prolongs chewing and swallowing movements;

2) increases fecal fat content;

3) inhibits absorption of carbohydrate in high fiber foods;

4) increases transit time and

5) alters the action of insulin, gut glucagon and other intestinal hormones.

The common idea is that fiber gives bulk/roughage to aid in defecation. Burkitt noticed in 1983 in Africa that people eating high fiber diets had reduced incidences of GI disease. Epidemiological evidence shows the converse in developed countries (remember the paradox with pregnancy and lactation, too).

Current research classifies fiber into 3 groups based upon their structure (chemistry) and properties.

Cellulose and Sources

Cellulose comes from and is a constituent of the main cell wall. It is poly-β-glucopyranosyl-β-glucopyranoside. It is insoluble fiber and holds water. It acts as a laxative and reduces colonic intraluminal pressure. It also binds minerals.

Selected sources of cellulose fibers include grains (bran, whole wheat, whole rye), fruits (apples, pears) and vegetables (beans, peas, cabbage family, root vegetables and fresh tomatoes).

The Non-Cellulose Polysaccharides

The non-cellulose polysaccharides are summarized, below in the table.

Dietary Fiber Class	Plant Part of Origin	Function
Hemicellulose	Secretions; cell wall material	Mostly insoluble; holds water, increases stool bulk; reduces colonic pressure; binds bile acids
Pectins	Intracellular cement material	Soluble, binds cholesterol and bile acids
Gums	Special cell secretions	Soluble; binds cholesterol and bile acids; slows gastric emptying; provide fermentable material for colonic bacteria with production of volatile fatty acids and gas
Mucilages	Cell secretions	Soluble; slows gastric emptying time; fermentable substrate for colonic bacteria; binds bile acids
Algal substances	Algae, seaweed	Soluble; slows gastric emptying time; fermentable substrate; binds bile acids

Hemicelluloses may be obtained from bran, cereals and whole grains.

Pectins may be obtained from fruits (apples, citrus, fruits, berries -- especially strawberries) and vegetables (green beans, carrots).

Gums may be found in grains (oatmeal) and vegetables (dried beans and other legumes).

Gums, mucilages and algal substances are used as food product thickeners and stabilizers.

Lignins and Sources

Non-carbohydrate fiber includes lignin, which comes from the woody part of plants. It is insoluble, it is an anti-oxidant and it binds bile acids and metals.

Lignins may be found in grains (whole wheat, whole rye), fruits (strawberries, peaches, pears, plums) and vegetables (mature vegetables).

There are Four Physiological Effects of Dietary Fiber

1) water absorption: The absorption of water leads to a bulkier stool and gives a laxative effect. This influences the transit time of the food mass through the bowel.

2) binding effect: The rate of absorption of nutrients is effected by the amount of time in the bowel. Non-cellulose fibers bind bile salts and cholesterol, preventing their absorption. Some of these binding effects are undesirable: excessive amounts of dietary fiber bind iron, zinc and/or calcium. These binding effects also effect lipid levels.

3) relation to colonic bacteria: Some non-cellulose dietary fibers (gums) provide fermentation substances for colon bacteria. This produces short chain fatty acids and gas.

4) satiety: Satiety is enhanced by fiber, since there is extra bulk. These foods also take more time to eat. This property regulates the amount of food eaten, it increases transit time in the bowel and it contributes to the management of obesity and diabetes.

Fiber and Cancer

For a number of years it was thought that fiber in the diet reduced the incidence of colon cancer by altering the kinds and amounts of bile acids and their metabolites in the bowel. It was thought that these chemicals altered the structure of the bowel, its cell turnover rate and the function of the resulting cell. An extensive study in late 1998 to mid-1999, though, has shown that this is not the case. It seems that fiber does NOT protect against bowel cancer. Interestingly enough, it appears that calcium may play a significant role in reducing the incidence of colon cancer.

Fiber and GI Disorders

In other GI disorders (diverticular disease, constipation, hiatal hernia and hemorrhoids), fiber

1) reduces pressure from within the intestinal lumen and

2) increases the diameter of the intestinal lumen, thus allowing the intestinal tract to contract more, propelling its contents more rapidly and inhibiting segmentations.

Fiber seems to do these by

1) increasing transit time,

2) increasing water absorption, resulting in a larger, softer stool and

3) increasing pressure and weakness along the walls of the GI tract.

Diabetes and Fiber

In the case of diabetes mellitus, it seems that there are at least 5 effects of fiber in the diet:

1) it reduces fasting blood sugar levels;

2) it reduces glycosuria;

3) it reduces insulin requirements;

4) it increases insulin sensitivity and

5) it inhibits postprandial hyperglycemia.

The modes of action are to, overall, slow carbohydrate absorption across the bowel. Fiber appears to do this by one of 5 mechanisms:

1) it delays gastric emptying time;

2) it forms gels with pectin or guar gum in the small bowel, thus impeding carbohydrate absorption;

3) by "protecting" carbohydrates from enzymatic activity with a fibrous coat;

4) by allowing "protected" carbohydrates to escape into the large bowel where they are digested by bacteria and

5) fiber alters gut hormone levels (glucagon) to enhance glucose metabolism in the liver.

Fiber and Coronary Artery Disease

In coronary artery disease (aka coronary heart disease), fiber 1) inhibits recirculation of bile acids and 2) reduces triglyceride and cholesterol levels (epidemiological evidence).

The putative mechanisms that this takes include

1) fiber alters bacterial metabolism of bile acids;

2) fiber alters bacterial flora, resulting in a change in metabolic activity;

3) fiber forms gels that bind bile acids;

4) fiber alters the function of pancreatic and intestinal enzymes;

5) fiber reduces insulin levels;

6) fiber binds cholesterol, preventing absorption and

7) fiber slows fat absorption by forming gel matrices in the intestine.