

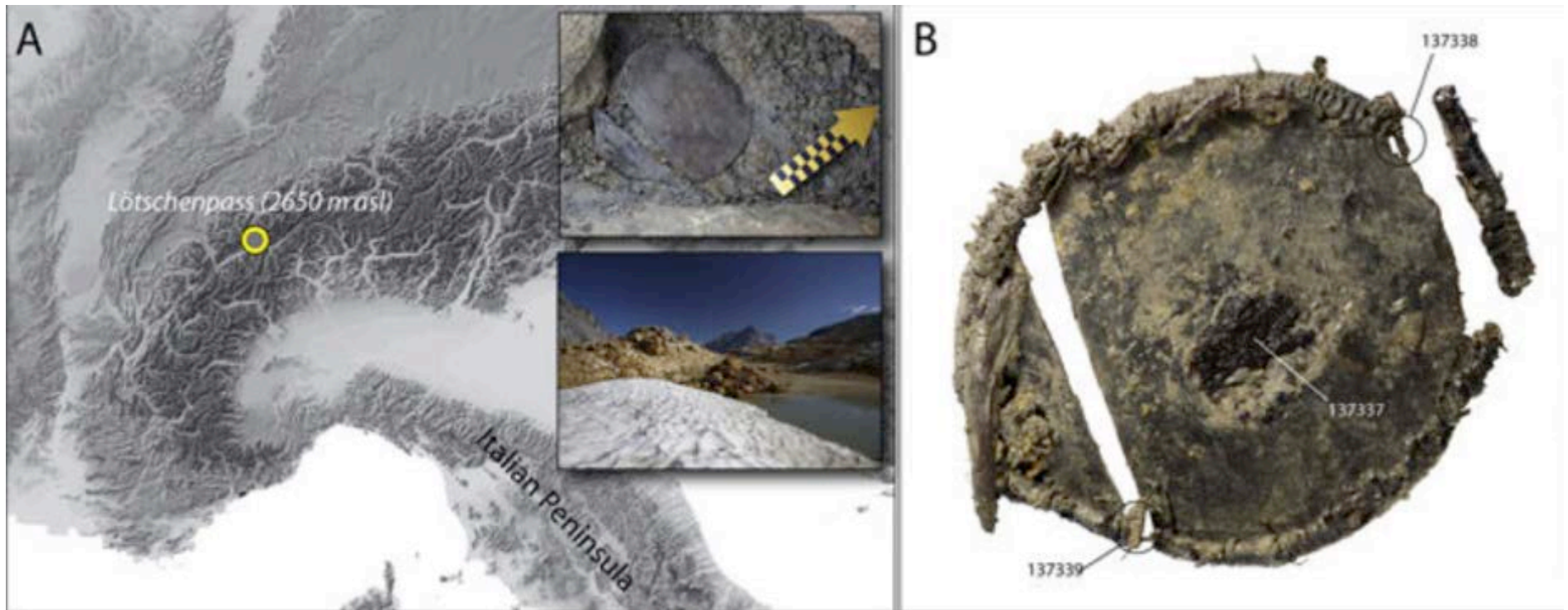
The Nutrition of Grains

A Wealth of Health

David W. Killilea, PhD
Nutrition & Metabolism Center
Children's Hospital Oakland Research Institute

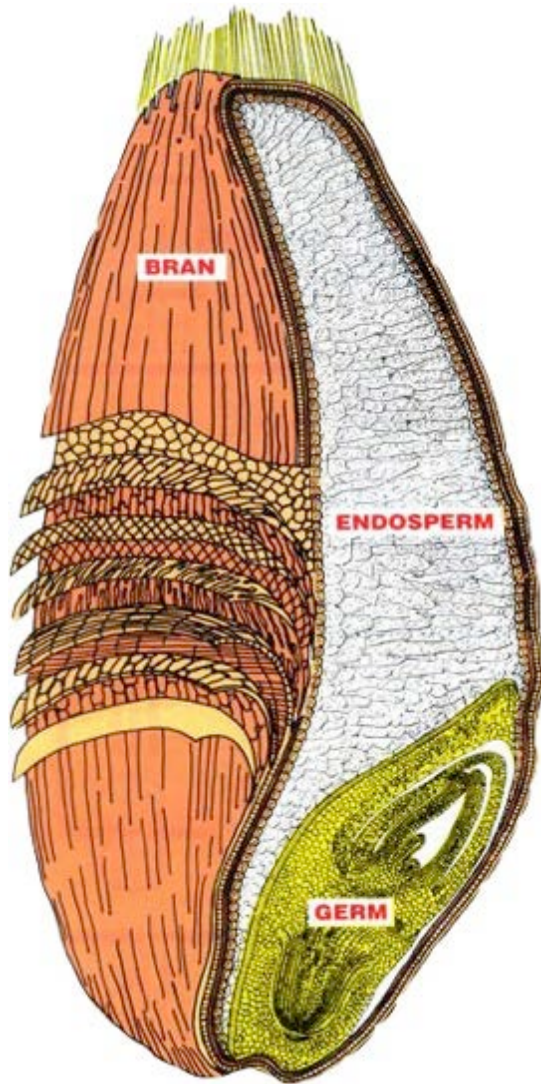
The greatest wealth is health - Virgil
The first wealth is health - Ralph Waldo Emerson

On the way to a Bronze Age Grain Gathering?



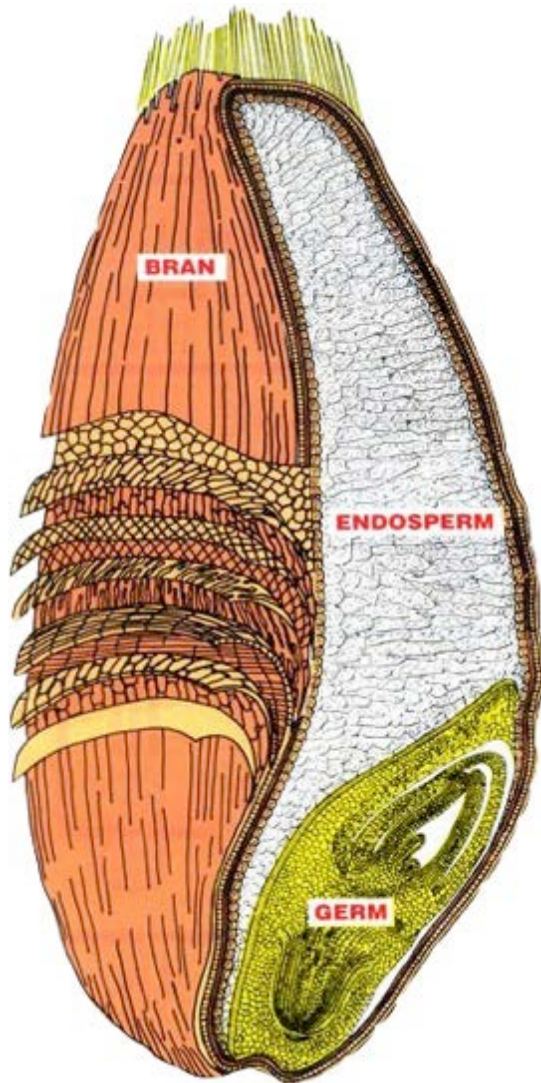
“The recent analysis of this mysterious content inside the 3500-year old lunch box allowed the researchers to discern fragments of spelt, emmer and barley, along with faint residues of wheat and rye. In essence, the ingredients suggest that the adventurer packed himself a hearty meal of whole-grain porridge.”

Before we begin ...



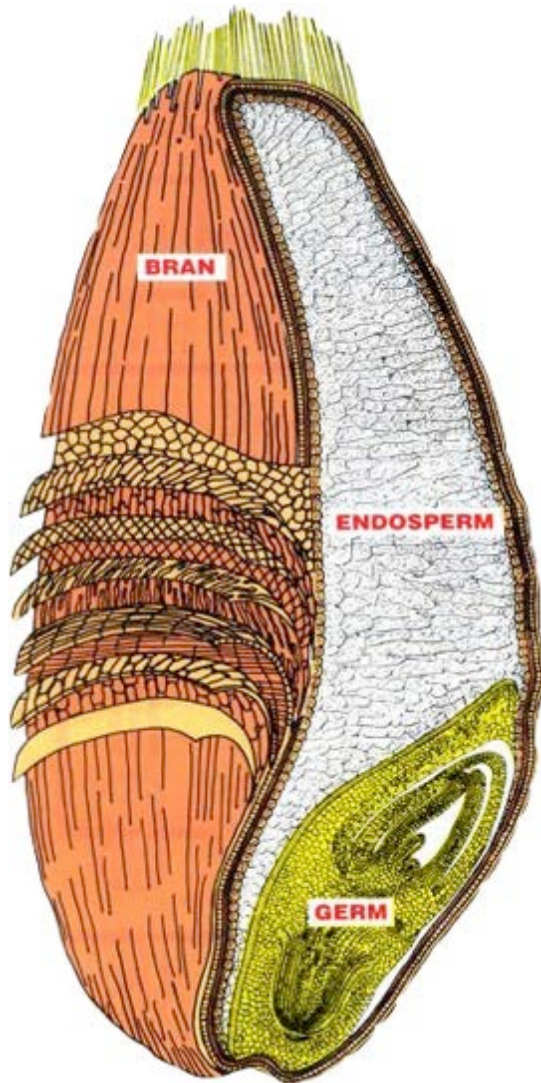
- no financial disclosures
- nutritional biochemist training
- may have a pro-wheat agenda
- focus on whole grain wheat

Outline



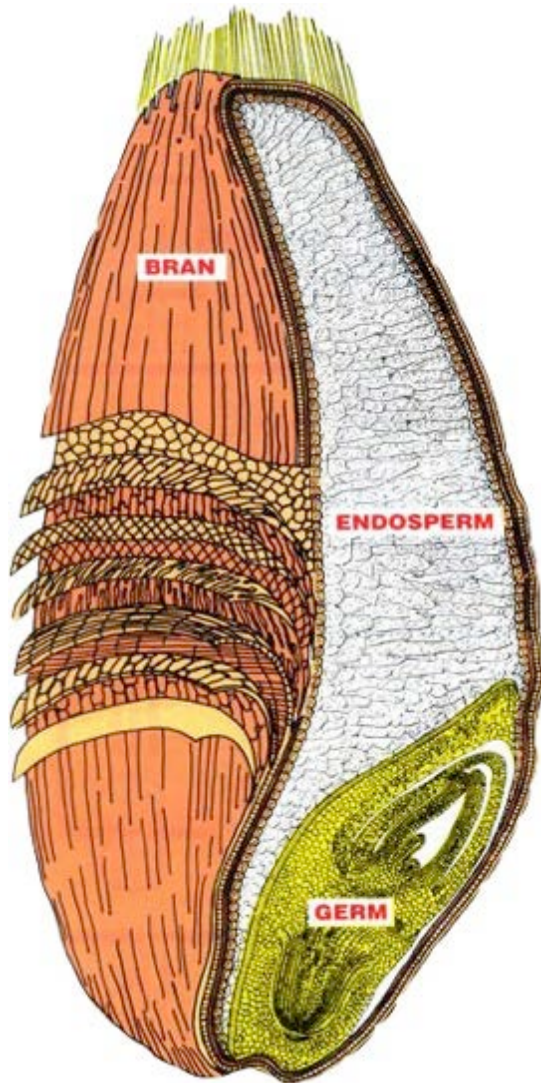
- why study wheat nutrition
- nutrients in wheat
- *anti*-nutrients in wheat
- putting it all together

Importance of wheat in US diet



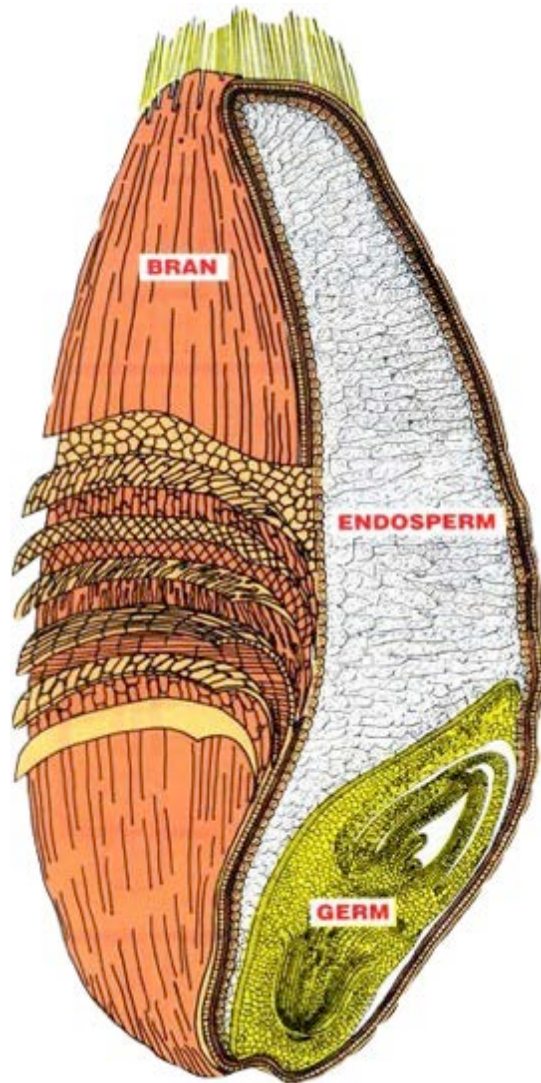
- Grains make up 20-40% of the US diet, with 60-80% of the grains coming from wheat.
- Whole grain consumption was inversely correlated with all-cause and disease specific morbidity and mortality.
- HHS & USDA recommend a minimum of 3 servings (of total 6 servings) of whole grain products daily.
 - only 8% adults and 3% kids in US get 3 servings
 - average 0.8 serv for adults and 0.5 serv for kids
 - ~40% of all US get little to no whole grains

Nutrients in whole wheat



- macronutrients
 - carbohydrates
 - protein
 - fats & oils
- micronutrients
 - vitamins
 - minerals
- other phytochemicals
 - fiber
 - flavinoids
 - lignans
 - phytosterols

Vitamins in whole wheat



Vitamin A (retinol)

Vitamin B

Vitamin B1 (thiamin)

Vitamin B2 (riboflavin)

Vitamin B3 group: (niacin, niacinamide)

Vitamin B5 (pantothenic acid)

Vitamin B6 group: (pyridoxine, pyridoxamine)

Vitamin B7 (biotin)

Vitamin B9 (folic acid)

Vitamin B12 (cobalamins)

Vitamin C (ascorbic acid)

Vitamin D (ergocalciferol, cholecalciferol)

Vitamin E (tocopherol, tocotrienols)

Vitamin K (naphthoquinoids)

Non-classical vitamins

Choline

Inositol

Carnitine

Lipoic Acid

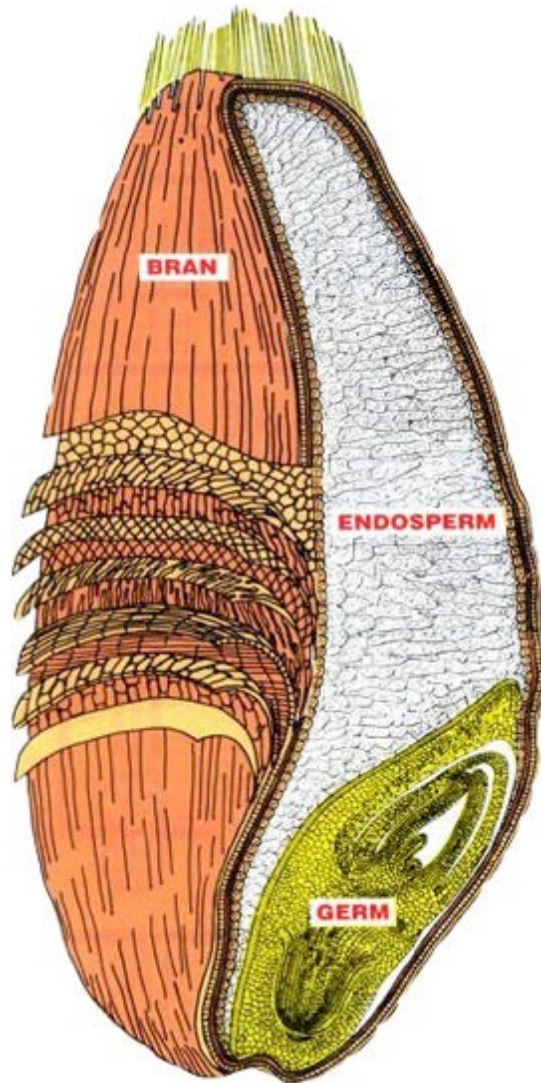
Taurine

Lutein

Orange vitamins are most abundant in whole wheat

David Killilea, 2017 Grain Gathering, The Bread Lab

Vitamins in whole wheat



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Vitamin B

Vitamin B1 (thiamin)

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Non-classical vitamins

Choline

Inositol

Carnitine

Lipoic Acid

Taurine

Lutein



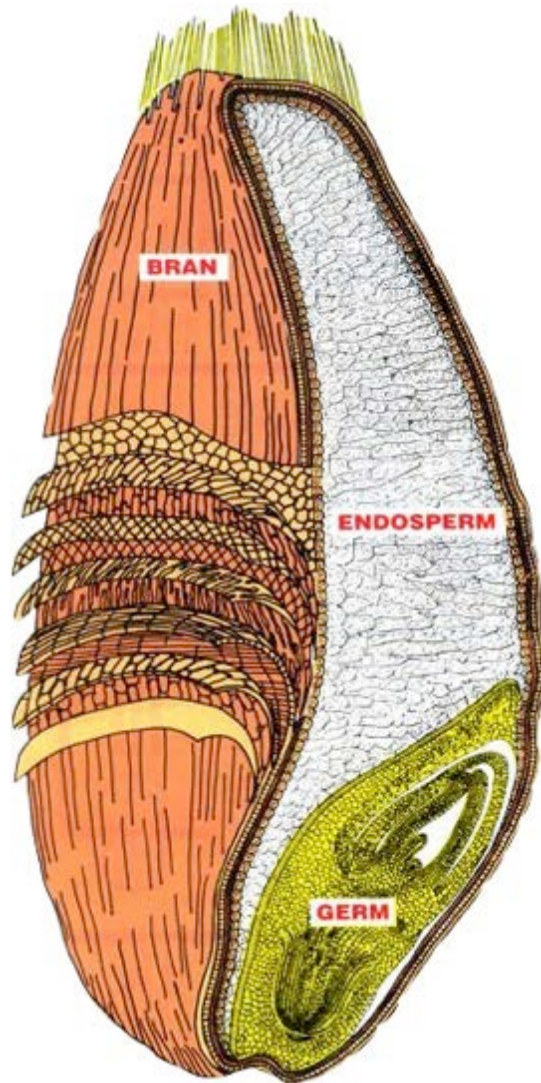
energy production
enzyme functions
sugar metabolism
lipid metabolism
cholesterol metabolism
DNA/RNA synthesis
DNA repair
antioxidants

anti-cancer activities
anti-diabetic activities
heart health
brain health
liver health
eye health
cognitive function
mood stabilization
hormone balance
weight management
wound healing
prevent birth defects

Orange vitamins are most abundant in whole wheat

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Minerals in whole wheat

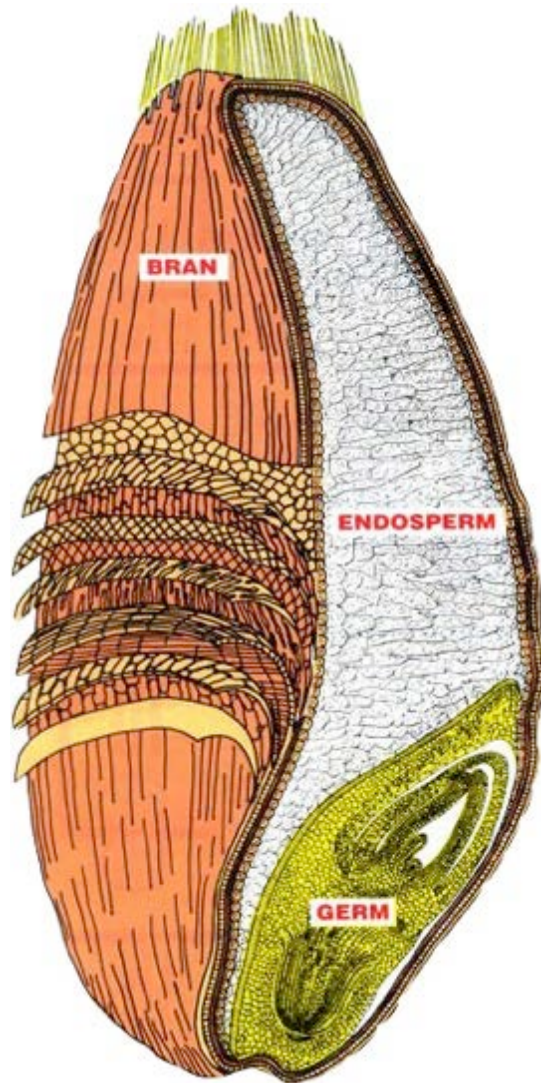


Boron
Calcium
Chloride
Chromium
Copper
Iodine
Iron
Magnesium
Manganese
Molybdenum
Phosphorus (phosphate)
Potassium
Selenium
Silicon
Sodium
Sulfur (sulfate)
Zinc

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Minerals in whole wheat



- Boron*
- Calcium
- Chloride
- Chromium*
- Copper*
- Iodine
- Iron*
- Magnesium*
- Manganese*
- Molybdenum*
- Phosphorus (phosphate)*
- Potassium*
- Selenium*
- Silicon*
- Sodium
- Sulfur (sulfate)
- Zinc*



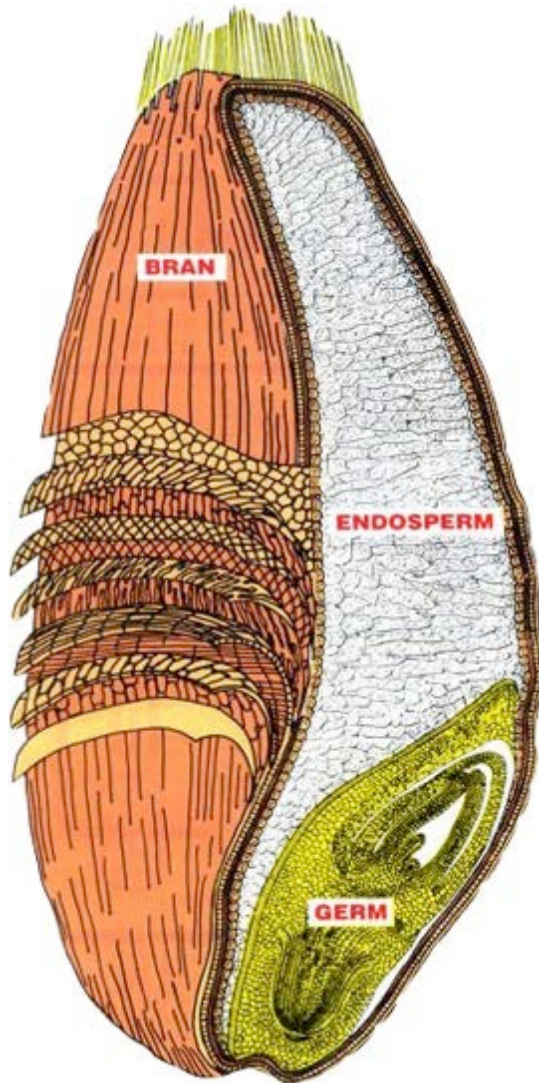
energy production
enzyme functions
sugar metabolism
lipid metabolism
cholesterol metabolism
DNA/RNA synthesis
DNA repair
pro-antioxidants

anti-cancer activities
anti-diabetic activities
heart health
brain health
liver health
bone health
cognitive function
mood stabilization
hormone balance
weight management
wound healing
reproductive health

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Fiber in whole wheat



types:

- cellulose
- pectin
- inulin
- arabinoxylan

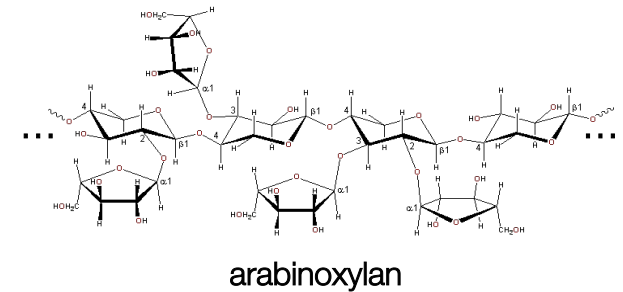
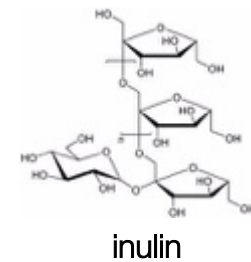
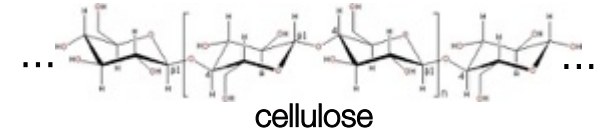
biological activities

- stool softening & mobility
- lower cholesterol
- improved insulin regulation
- weight control
- utilized/modified by gut bacteria

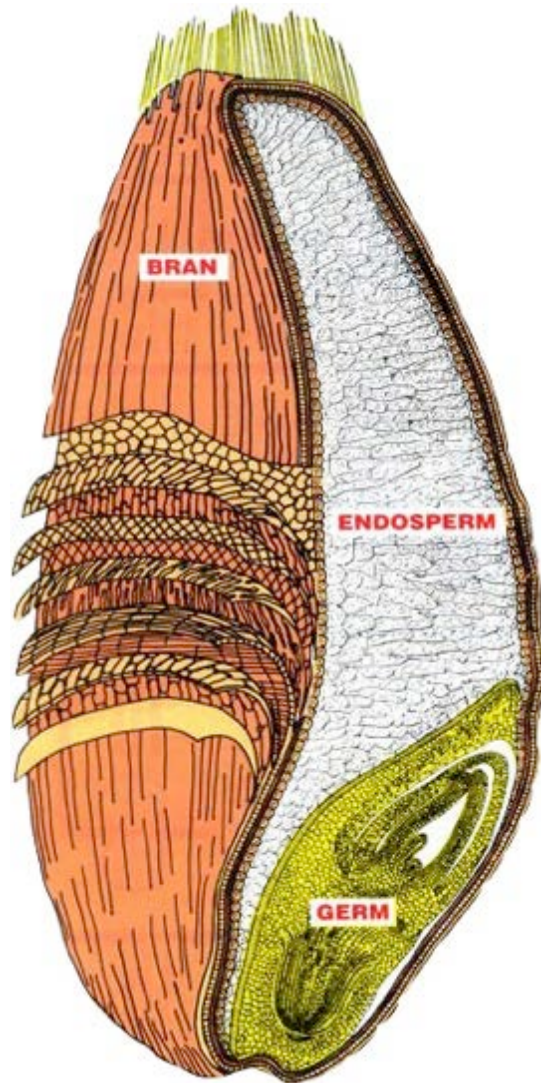
disease prevention

- diabetes
- cancer
- irritable bowel syndrome
- gut inflammation

recommended 25 – 38 grams/day



Flavinoids in whole wheat



types:

- anthocyanidin (e.g. in red wine)
- catechins (e.g. in green tea)
- genisten (e.g. in soy)
- quercetin (e.g. in berries)

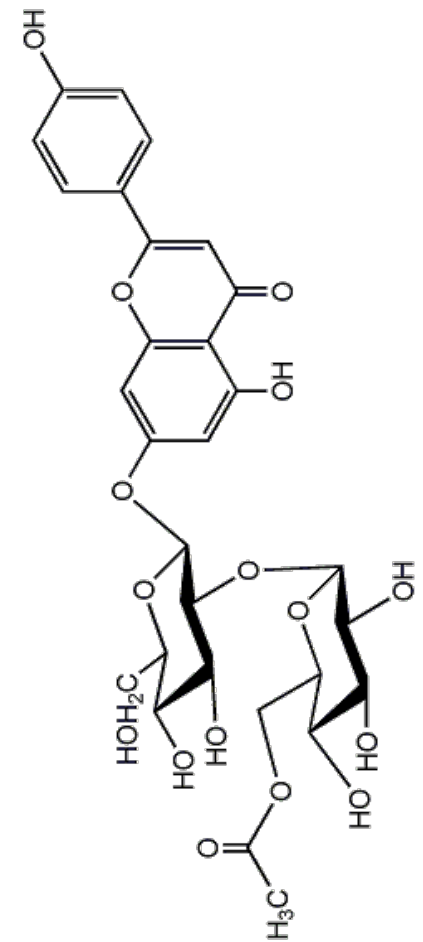
biological activities

- antioxidants
- stimulate metabolism
- stimulate detoxification pathways
- weight control
- utilized/modified by gut bacteria

disease prevention

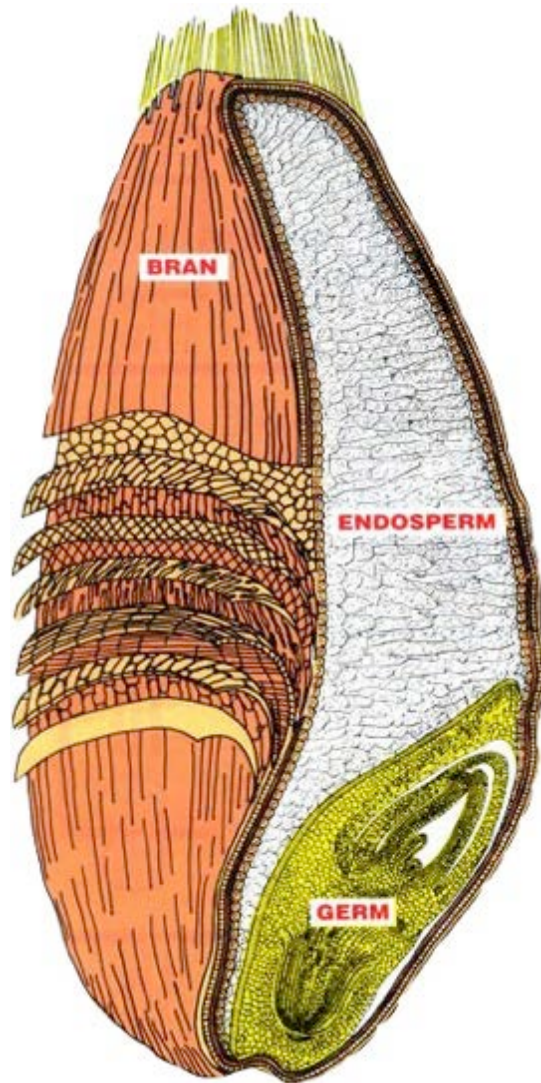
- diabetes
- cancer
- cardiovascular disease
- brain function
- gut inflammation

no intake recommendation



apigenin-C-diglycoside

Lignans in whole wheat



types:

- 100s of different types
- metabolized by intestinal bacteria to enterodiol and enterolactone

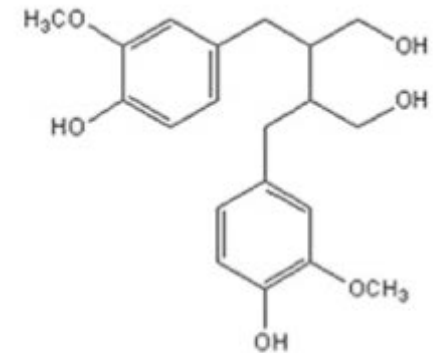
biological activities

- antioxidants
- estrogenic
- stimulate detoxification pathways
- weight control
- utilized/modified by gut bacteria

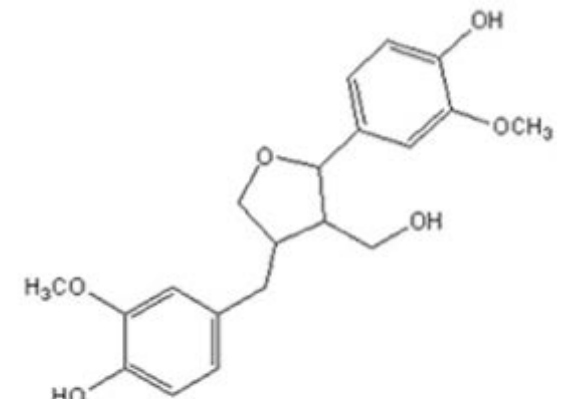
disease prevention

- cancer
- cardiovascular disease
- osteoporosis
- gut inflammation

no intake recommendation

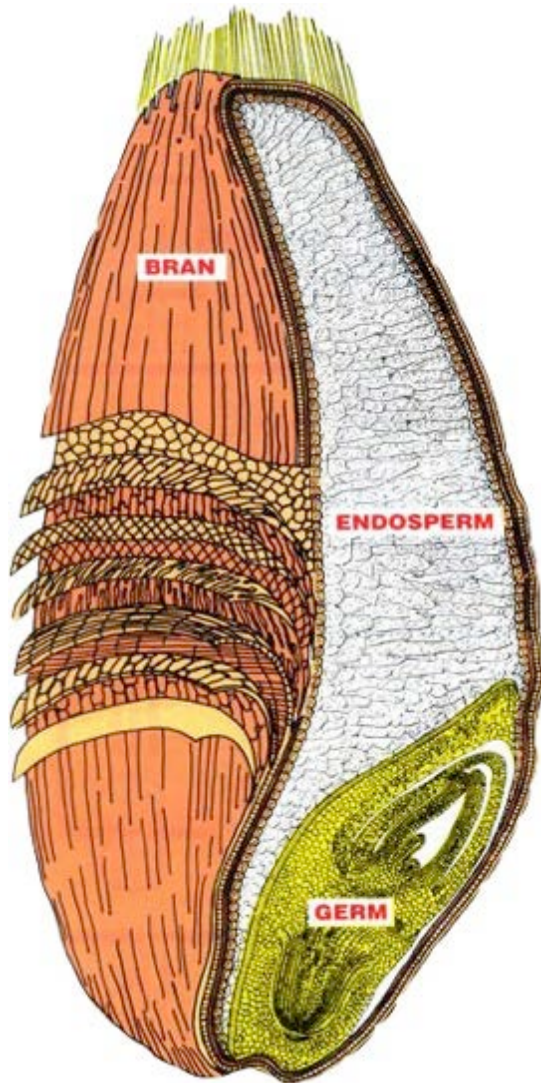


Secoisolariciresinol



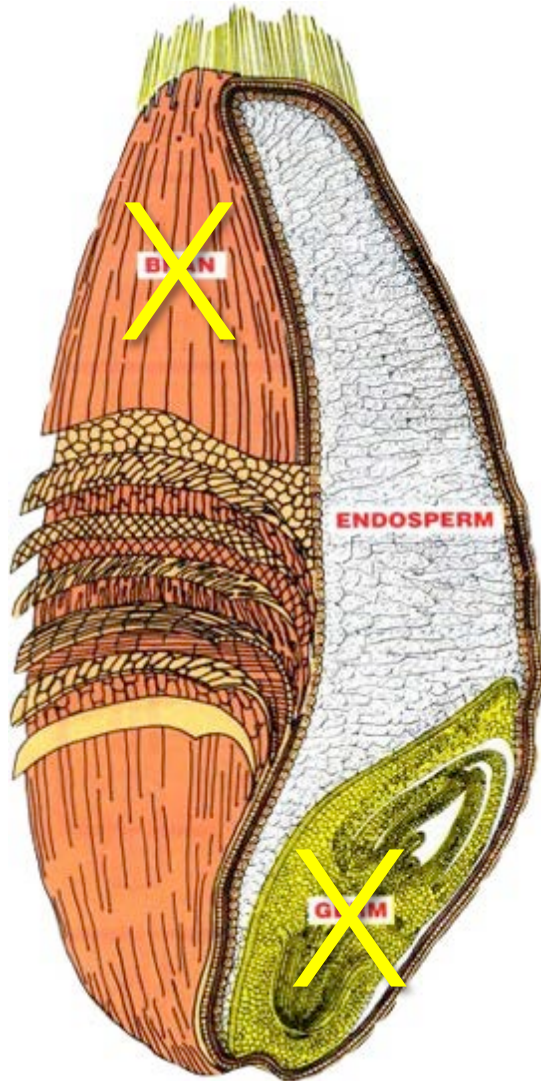
Lariciresinol

Nutrients in *whole* wheat flour



- macronutrients
 - carbohydrates
 - protein
 - fats & oils
- micronutrients
 - vitamins
 - minerals
- other phytochemicals
 - fiber
 - flavinoids
 - lignans
 - phytosterols

Nutrients in *refined* wheat flour



- macronutrients

- carbohydrates
- protein
- ~~fats & oils~~

- micronutrients

- ~~vitamins~~ + vitamins B1,2,3,&9
- ~~minerals~~ + iron

- other phytochemicals

- ~~fiber~~
- ~~flavonoids~~
- ~~lignans~~
- ~~phytosterols~~

Orange vitamins & minerals are fortified in some refined flours

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Anti-nutrients in wheat



- structural/storage proteins
 - glutens
 - glutelins, e.g. glutenin
 - prolamins, e.g. gliadin
- nutrient storage/chelation
 - phytates
 - flavinoids
- immune/consumption defense
 - lectins
 - amylase trypsin inhibitors

Orange anti-nutrients are of key focus in wheat

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Glutens in whole wheat

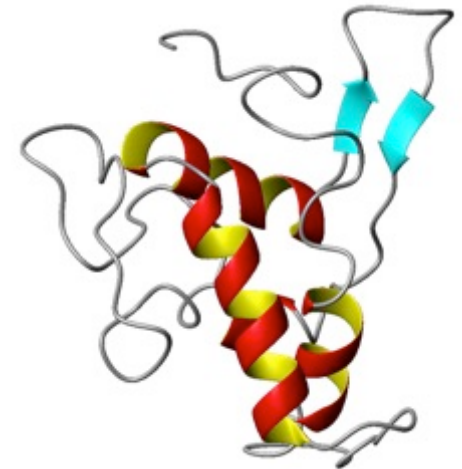


description:

- 100s of different gluten proteins
- 80-90% of protein in wheat
- structural and nutrient storage roles
- slow or incomplete proteolysis
- potential to trigger immune response

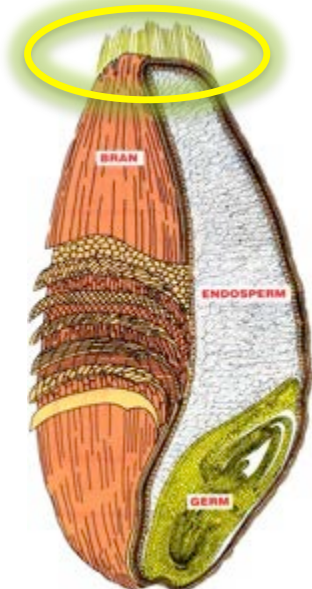
biological activities

- gut irritant
- react with gut & become immunogenic
- repeated exposure degrades gut wall
- gluten peptides may have neurologic effects



glutenin
(ribbon diagram)

Glutens in whole wheat



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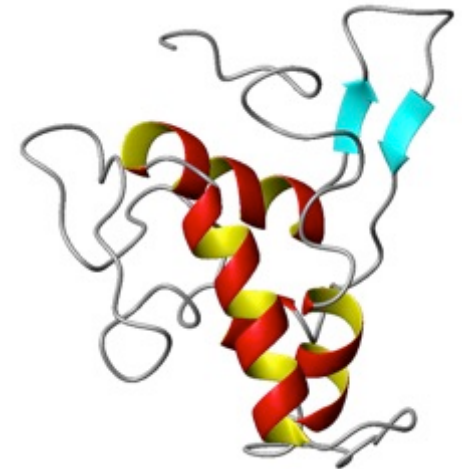
biological activities

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- repeated exposure degrades gut wall
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other activities or functions

- provide structure for bread products
- use as substitute for meat (seitan)
- one study: higher gluten, lower diabetes risk
- one study: higher gluten, lower heart disease risk

4-5g gluten per wheat serving, so 10-40g intake is common



glutenin
(ribbon diagram)

Phytates in whole wheat

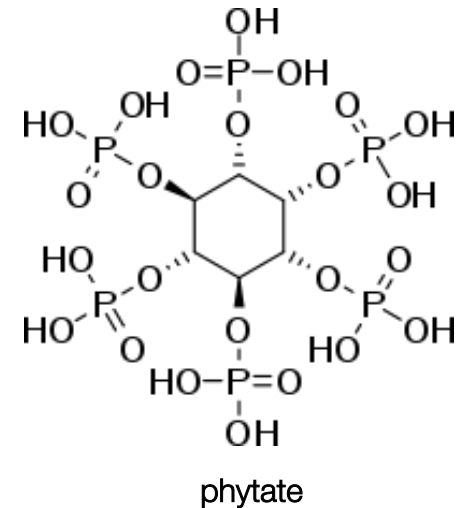


description:

- range of different phytates
- dual nutrient storage roles
- degraded upon germination
- degraded by heat and fermentation
- potential to trigger immune response

biological activities

- not degraded by animal digestion systems
- most not absorbed, pass out with feces
- block mineral absorption (calcium, iron & zinc)



Phytates in whole wheat

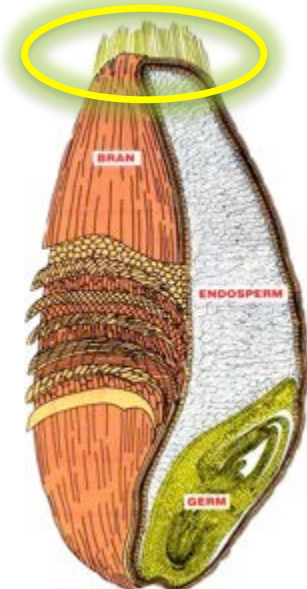


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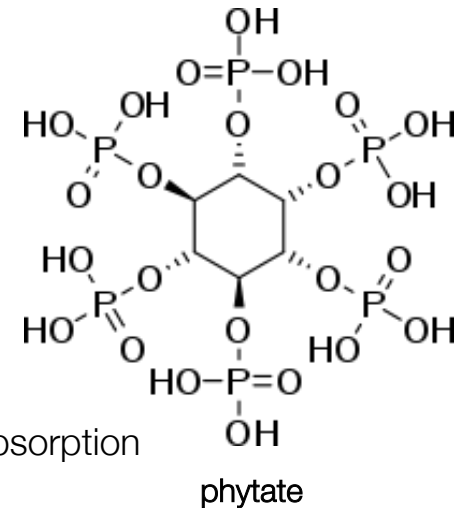
- not degraded by animal digestion systems
- most not absorbed, pass out with feces
- block mineral absorption (calcium, iron & zinc)



other activities or functions

- lower phosphate forms may assist in mineral absorption
- some is absorbed into the body
- may participate in mineral balance inside body
- antioxidant activity
- anti-cancer activity
- anti-kidney stone & calcification

average intake of 750mg, higher in mostly plant-based diets



Lectins in whole wheat

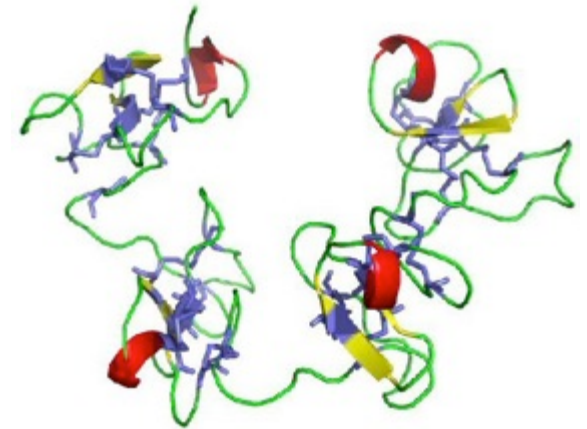


description:

- common & many different types of lectin proteins
- lectins bind certain carbohydrates (like antibodies)
- immune defense & anti-predation roles
- degraded by heat and fermentation
- potential to cause prolonged immune response

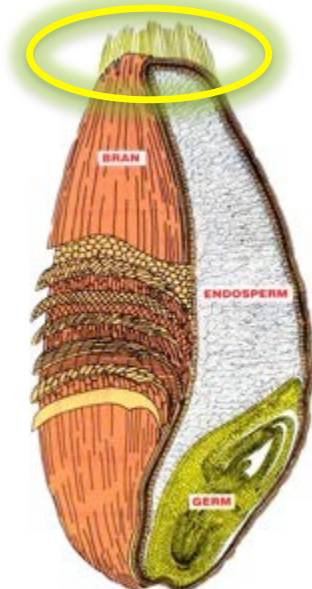
biological activities

- gut irritant
- react with gut walls & barriers
- triggers strong immune response
- potentially interfere with satiety



lectin
(ribbon diagram)

Lectins in whole wheat



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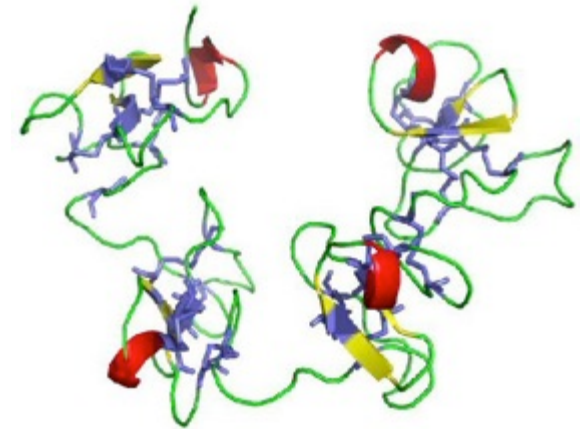
biological activities

- gut irritant
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other activities or functions

- anti-microbial activity in our gut
- moderate levels help stimulate immune system
- potential anti-cancer activity
- active ingredients in bitter melon & garlic
- degraded by soaking, sprouting and fermentation

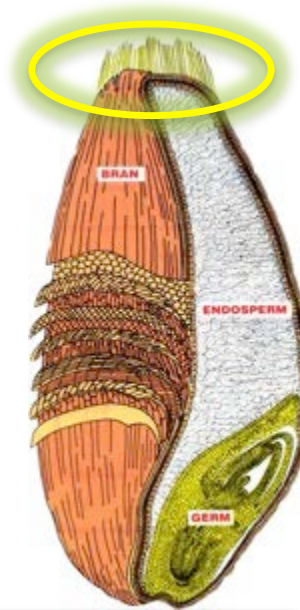
lectins are common in our diet, higher in mostly plant-based diets



lectin
(ribbon diagram)

Balancing act of health benefits/consequences in whole wheat

gut irritants
 mineral chelators
 immune activators
 bio-active peptides
 fungal toxins
 bacterial toxins
 heavy metals



energy
 fats & oils
 vitamins
 minerals
 fibers
 flavonoids
 lignans
 phytosterols
 pro-gut agents

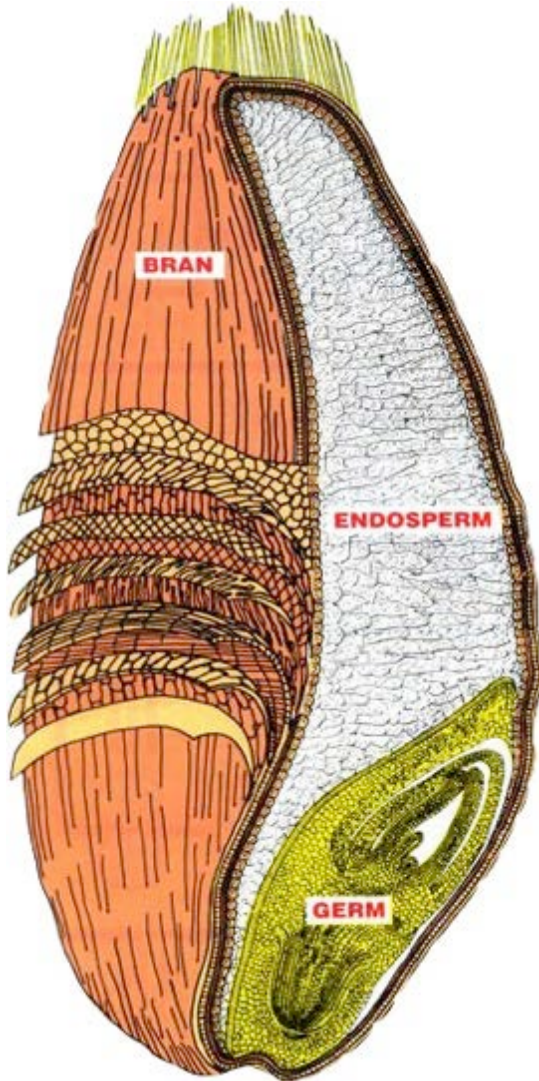
malting
 baking
 cooking

diet
 genetics
 sleep quality
 stress tolerance
 activity & exercise
 pre-existing gut stress

soaking
 sprouting
 fermentation

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The preponderance of evidence shows that for most healthy people, whole wheat consumption has an overall positive health benefit



Like most foods, whole wheat has a mix of positive and negative compounds that affect health and nutrition. Wheat kernels contain many vitamins, minerals, fibers, and numerous other phytochemicals that contribute to a healthy metabolism and microbiome. Wheat kernels also contain gut irritants and other compounds that can negatively affect health in some people. The set point of the balance between positive and negative is defined by overall diet, genetics, environmental conditions, and pre-existing gut inflammation. Moreover, the levels and availability of the compounds in wheat are strongly affected by how the wheat is processed and manipulated into food products. For most healthy people though, whole wheat consumption results in an overall positive health benefit.

Acknowledgements



- Mark Shigenaga, PhD
- Ron Krauss, MD
- Stephen Jones, PhD & team
- Andrew Ross, PhD
- Bob Klein & team
- Kathy Schultz, MS