Chapter 5
Wheat Flour

How Baking Works

Words, Phrases, and Concepts

- Endosperm
- Germ
- Bran
- Whole grain
- Gluten, glutenin, gliadin
- Dietary fiber
- Whole wheat flour and wheat flour
- Hard and soft wheats
- Soaker
- Bleaching and maturing agents
- Amylase and falling number
- Malting
- Patent, clear, straight flours
- Aleurone
- Absorption value

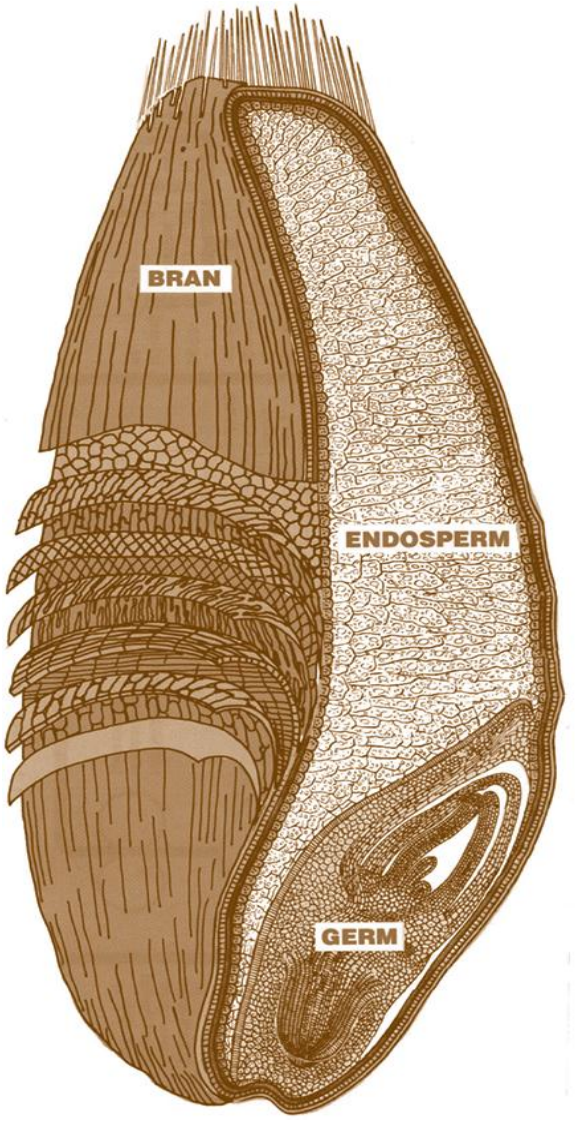
Introduction

Wheat:

- Is a cereal grain.
- Most widely grown grain in world.
  - Thousands of varieties available, adapted to different climates.
- Most popular grain in baking.
  - Forms gluten.
  - Mild, nutty flavor.

Wheat Kernel

- Also called:
  - Wheat grain
  - Wheat berry
- Three main parts:
  - Endosperm
  - Germ
  - Bran



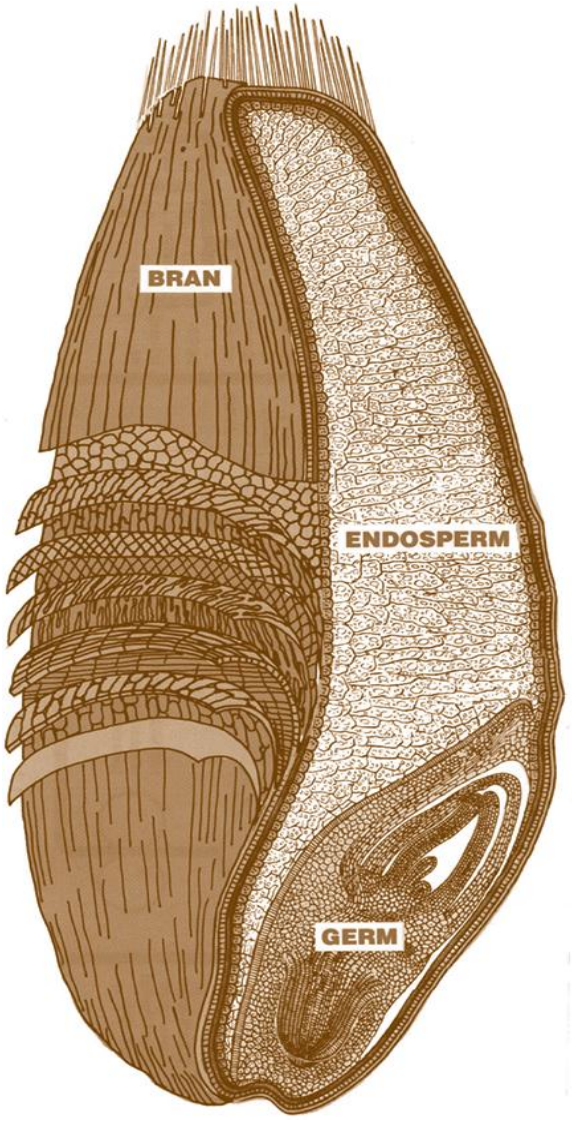
Wheat Kernel

Whole wheat flour:

- Is ground from entire wheat kernel.
- Is a whole grain.

White flour:

- Is ground from white endosperm.
- Also called “wheat flour”



Wheat Kernel

- Whether cracked, crushed, rolled, or ground, whole grains have the same amount of bran, germ, and endosperm as the original grain.
- Whole grains can reduce risk of certain diseases.

Wheat Kernel

Endosperm

- Contains mostly starch.
  - Starch is tightly packed inside granules.
  - Embedded in chunks of protein.
- Two important proteins: glutenin and gliadin.
  - Form gluten when flour is mixed with water.
  - Gluten network is important in structure of baked goods.

Wheat Kernel

Wheat germ:

- Is the embryo of the wheat plant.
- Sprouts, or germinates, into new plant.
- High in nutrients.
- Can be purchased toasted.
  - Nutty flavor.
  - Less likely to oxidize and turn rancid.

Wheat Kernel

Bran

- Protective outer layer of kernel.
- High in dietary fiber.
  - Mostly insoluble fiber.
  - Good for health.
- Softens and swells when wet.
- Can be purchased as flakes.
  - Adds appealing rustic appearance to baked goods.
  - Valuable source of dietary fiber.

Makeup of Flour

White flour:

- Ground endosperm.
- Also called wheat flour.
  - Do not confuse wheat flour with whole wheat flour.
- Key components:
  - starch
  - gluten-forming proteins

Makeup of Flour

White flour (cont.):

- Also contains:
  - Enzymes (proteins)
  - Moisture
  - Pentosan gums
  - Lipids
  - Ash
  - Carotenoid pigments

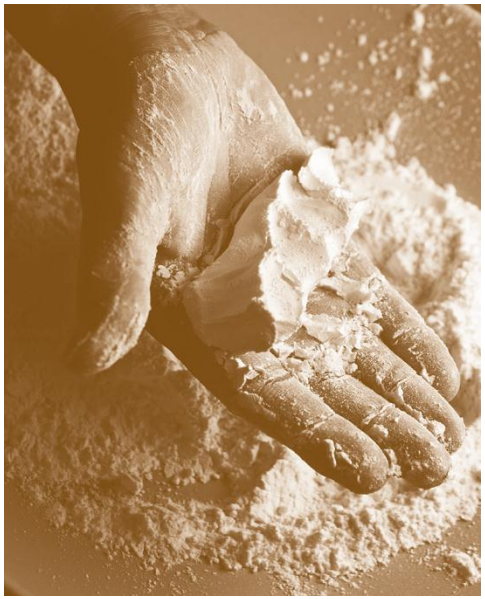
Classifying Wheat

- Wheat kernels: classified as hard or soft.
- Additional ways of classifying: color of kernel, planting time, botanical species.
- Six major classes of wheat in U.S.:
  - Hard red winter
  - Soft red winter
  - Hard red spring
  - Hard white
  - Soft white
  - Durum

Classifying Wheat

Hard kernels are hard to mill.

- Starch granules are damaged during milling.
  - Absorb water more easily.
- Flours are coarse and gritty.
  - Do not pack well when squeezed in fist.
  - Good for dusting bench.



Classifying Wheat

Hard Wheat Flours	Soft Wheat Flours
Bread and high gluten flour	Cake and pastry flour
Form strong gluten	Form weak gluten
Gritty to touch	Soft and silky
Do not pack well	Pack when squeezed
Yeast-raised breads	Cakes, cookies

Particle Size

From largest to smallest in size:

- Wheat berries
- Cracked wheat and rolled wheat flakes
- Farina and durum semolina
- Flours, coarse and fine

Particle Size

Large grain particles:

- Absorb water slowly.
- Require gentle heating or overnight soaking
  - Soaked, softened grains called “soakers”
  - Can be good source of enzyme activity

Additives and Treatments

- Vitamins and minerals
  - Added to enriched flour
  - Iron, thiamin, riboflavin, niacin, folic acid
- Natural aging
  - Air (oxygen) is the “additive”
- Bleaching and maturing agents
  - Potassium bromate
  - Ascorbic acid and other bromate replacers
  - Benzoyl peroxide
  - Chlorine

Additives and Treatments

Additive	Carotenoids	Gluten	Starch	Use
Air (oxygen)	Whitens	Strengthens	---------	All flours
Potassium bromate	---------	Strengthens	---------	High-gluten flour
Ascorbic acid	---------	Strengthens	---------	High-gluten and some bread flours
Benzoyl peroxide	Whitens	---------	---------	All flours
Chlorine	Whitens	Weakens	Increases ability to absorb water	Cake flour

Additives and Treatments

- Amylase
  - Enzyme; breaks down starch into sugars
    - Most active on damaged starch granules (from milling)
    - Activity increases during early stages of baking
  - Has multiple functions
    - Provides food for yeast fermentation
    - Increases brown color and flavor from baking
    - Softens crumb and slows staling
  - Falling number: measure of amylase activity in flour

Additives and Treatments

- Amylase
  - Good sources:
    - Sprouted wheat berries
    - Soakers
    - Diastatic malt syrup
    - Rye flour
    - Untoasted soy flour
    - Malted flour
    - Dough conditioners

Additives and Treatments

- Amylase activity decreases when:
  - Amount of salt in dough is increased.
  - Baking temperature is increased.
  - Dough is retarded (refrigerated during fermentation).

Additives and Treatments

- Malted flour
  - Grains of barley are malted, or sprouted, before drying and pulverizing.
  - Used for its enzyme activity.
    - Amylase and protease
  - Also called dry malt, or simply malt.
  - Commonly added:
    - By miller to bread and high gluten flour.
    - By baker to yeast doughs.

Additives and Treatments

- Dough conditioners
  - Also called dough improvers
  - Added to yeast doughs
  - Multi-functional; most common benefit:
    - Strong gluten; for high volume and fine crumb.
  - Uses
    - Large-scale bread bakeries
    - Frozen yeast doughs
    - To eliminate bulk fermentation of yeast dough
      - Saves time, but flavor is sacrificed

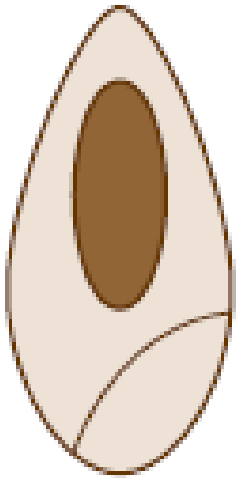
Additives and Treatments

- Vital wheat gluten
  - Mostly gluten (up to 75 percent)
  - Creamy yellow powder
  - Added to yeast-raised doughs
    - Improves flour quality
    - Increases water absorption
  - Starting point: add 2-5 percent of flour weight

Commercial Grades of Flour

Patent flour: from heart of endosperm

- Whitest in color, lowest in ash.
- Most expensive.
- Most white flours are patent flours.



Commercial Grades of Flour

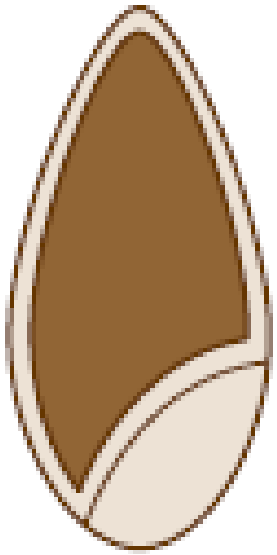
Clear flour: from outer part of endosperm

- Contains aleurone layer
  - Nutrient rich
  - High in enzyme activity
- Used in rye and multi-grain breads

Commercial Grades of Flour

Straight flour: from entire endosperm

- Not commonly used in U.S.



Patent Wheat Flours

Bread flour

- From hard red spring or hard red winter wheat
- High in gluten-forming proteins
- Unbleached or bleached
- Often contains malted barley flour
- Uses: breads, rolls, croissants, sweet yeast doughs

Patent Wheat Flours

Artisan bread flour

- From hard red winter wheat
- Compared with regular bread flour:
  - Lower in gluten-forming proteins (for irregular crumb)
  - Less water absorption (for crisper crusts)
  - Usually no added bleaching or maturing agents
- Uses: crusty lean baguettes, flat breads (tortillas, pita)

Patent Wheat Flours

High-gluten flour

- Generally from hard red spring wheat
- Highest in gluten-forming proteins
- Compared with bread flour:
  - Higher water absorption
  - Requires more mixing to fully develop
  - Sometimes bromated
- Like bread flour:
  - Unbleached or bleached
  - Often contains malted barley flour
- Uses: bagels, thin crust pizzas, hard rolls

Patent Wheat Flours

Pastry flour

- From soft wheat
- Low in gluten-forming proteins
- Usually unbleached
- Low water absorption
  - High spread in cookie dough
- Uses: cookies, pie pastry dough, muffins, cakes

Patent Wheat Flours

Cake flour

- From soft wheat
- Also called chlorinated or high-ratio flour
- Stark white – highly bleached
- Chlorine treatment:
  - Increases water absorption, for thicker batters and stiffer doughs
  - Weakens gluten
- Uses: high-ratio cakes, cookies

Patent Wheat Flours

All-purpose flour

- From hard wheat, soft wheat, or blend
- Also called H&R (hotel and restaurant) flour
- Unbleached or bleached
- Substitute with 60/40 or 50/50 blend of bread flour and cake flour
- Uses: breads, cakes, cookies, muffins, pastries

Other Wheat Flours

Whole wheat flour

- From hard red wheat
  - Whole wheat pastry flour is milled from soft wheat
- Also called graham or entire wheat flour
- A whole grain
- Many granulations available, from fine to coarse
- Compared with white flour:
  - Has higher absorption value; is a better drier
  - Forms less gluten
  - Baked goods are: denser, darker, stronger in flavor

Other Wheat Flours

Whole white wheat flour

- From white wheat; hard or soft
- Golden (not white) in color
- A whole grain
- Compared with regular (red) whole wheat flour:
  - Lighter in color
  - Milder in taste
  - Same amount of dietary fiber

Other Wheat Flours

Durum flour and durum semolina

- From endosperm of durum wheat
  - Not whole grain
- Durum flour is fine; also called semolina flour.
- Durum semolina is coarse; looks like cornmeal.
- Compared with white flour:
  - Yellow in color (high in carotenoids)
  - Very high in protein
  - Very hard kernel; hard to mill
- Uses: pasta, semolina bread

Functions of Flour

1. Providing structure
   - Essential in many baked goods and pastries
     - Holds size and shape of leavened baked goods; prevents collapse.
     - Provides thickening in pastry creams, pie fillings.
   - From gluten, starches, and pentosan gums
     - Gluten is important in pie crusts and crisp, dry cookies.
     - Starch is important in high-ratio cakes, muffins, and cake-like brownies and cookies.
     - Both important in yeast-raised breads.

Functions of Flour

2. Absorbing liquids
   - Is a drier
     - Absorption value of flour: amount of water absorbed by flour when forming bread dough.
   - From gluten, starches, and pentosan gums
     - High-protein flours have higher absorption value than low-protein flours.
       - From protein, damaged starch granules, and pentosan gums.
     - Chlorinated cake flours have high absorption value because of chlorine's effects on starch granules.

Functions of Flour

3. Contributing flavor
   - Wheat: mild, nutty flavor
     - Flours differ in flavor.
     - Whole wheat flour: strongest flavor.

Functions of Flour

4. Contributing color
   - From three sources
     - Pigments in bran layer
       - Red wheat bran is brown in color; white wheat is gold.
     - Carotenoids in endosperm
       - Durum wheat is highest in carotenoids; yellow in color.
       - Carotenoids whiten when bleached.
     - Maillard browning during baking
       - High-protein flours typically brown more when baked than low-protein flours.

Functions of Flour

5. Adding nutritional value
   - Contribute starch, vitamins, minerals, and protein.
     - Protein in flour is low in lysine, an essential amino acid.
   - Whole wheat flour is better nutritionally than white flour.
     - Contains dietary fiber and many unidentified health-promoting substances.
     - Offers protection against certain diseases.

Storage of Flours

Flour has limited shelf life.

- Six months maximum.
- Oils oxidize when exposed to air.
  - Develops rancid, cardboard-like off flavors,
- Whole wheat flour most susceptible.
  - Bran and germ contain most of the oils in flour.

Storage of Flours

When storing flour:

- Rotate stock: practice FIFO (first in, first out).
- Do not add new flour to old.
- Cover bins and store in cool, dry area.
  - Ideally, store wheat germ and bran under refrigeration.
- Watch for infestation from insects and rodents.
  - Silky cobwebs are a sign of flour moths.
- Be especially vigilant with whole grains.