

Bread

Flat/Unleavened breads

Grains ground with water and cooked

More palatable, transportation advantage



Image: http://www.indianfoodsite.com/breads_indian_paratha.htm



Image: http://www.cepolina.com/bread_Muslim_unleavened.html



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Unleavened Breads

Tortillas

Lavash

Matzah

Thin and often cracker-like



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“Leavening”

Chemical or Biological
Forming and trapping gas



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Chemical Leavening

Carbonates + Acid = CO₂(g)

Relatively fast gas formation

Little other character

“Quickbreads”

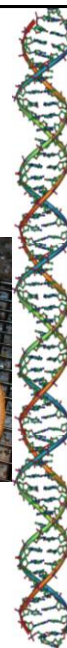
“Soda bread”

Cakes



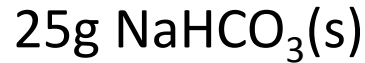
Images: <http://www.bellaonline.com/articles/art65628.asp>
<http://www.diabetesselfmanagement.com/recipes/Breads/>
http://www.salon.com/2010/08/12/irish_soda_bread_how_to_make_quickbreads/

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How much CO₂(g)?

1 Tablespoon Baking Soda =

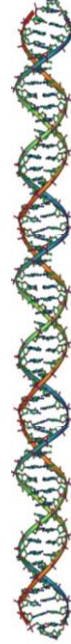


Can produce ~7L of CO₂(g)

7L = 1.9 gallon



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Trapping the gas

Need a network of large molecules

Protein!

Gluten = long protein chains

Glutenins link together, form gluten

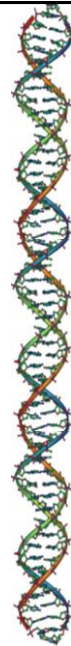
Disulfide bonds = strong

Longer glutens = chewier bread

Kneading...



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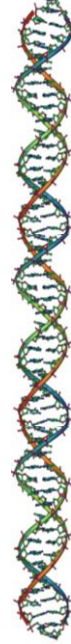


Modifying Gluten

Flour type – high protein (↑ gluten)
 Oxidizing substances (↑ gluten)
 “Wet” dough (↑ gluten)
 Lots of kneading/mixing (↑ gluten)
 Salt (↑ gluten)
 Sugar (↓ gluten)
 Fats & Oils (↓ gluten)
 Acid (↓ gluten)

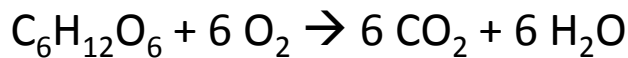


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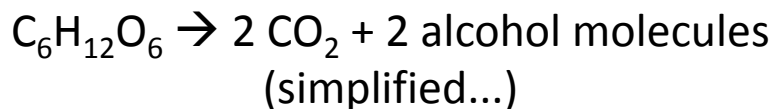


Yeast

Ubiquitous microorganism
 Many “yeasts”
 Aerobic:



Yeast:

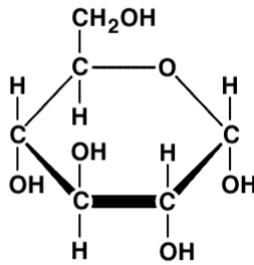
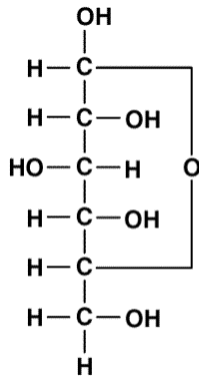


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Aerobic

Aerobic digestion = "burning"



Glucose

6 carbons

12 hydrogens

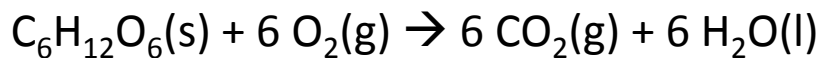
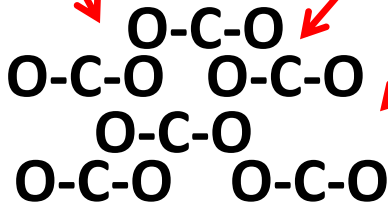
6 oxygens

Source: <http://imgarcade.com/1/c6h12o6-molecule/>



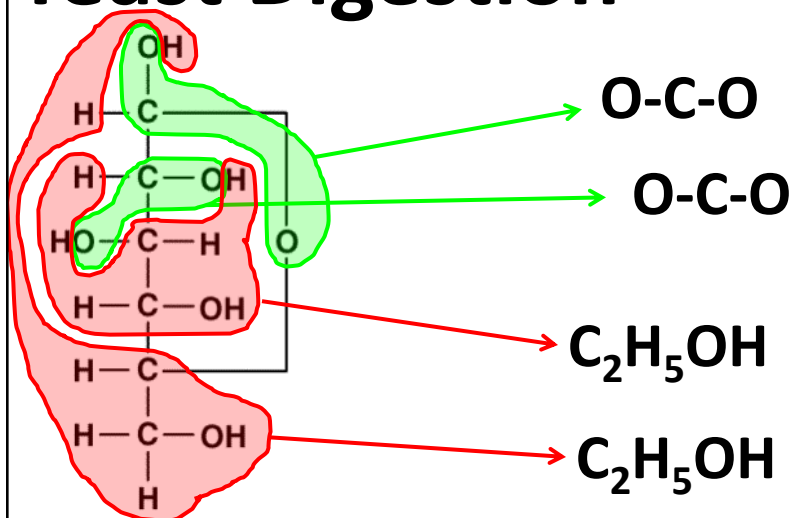
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Aerobic "Digestion"



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Yeast Digestion



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Yeast leavening

Slower

Other flavors develop

Continuous yeast culture

“New kitchen” syndrome

“friendship breads”



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Amount of Gas...

Gas changes volume with amount
Avogadro's Law

Volume \propto Amount

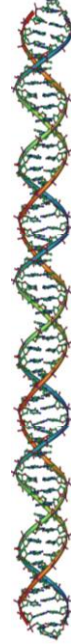
$$V \propto n$$

$$V = kn$$

$$V / n = k$$



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Temperature...

Gas changes volume with temp.
Charles' Law

Volume \propto Temperature

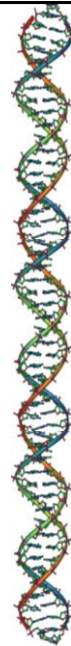
$$V \propto T$$

$$V = kT$$

$$V / T = k$$



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Bread Structure

Glutens form a network to trap CO₂
Wheat flour is mostly starch...

Recall meringues set by heat...
Albumin proteins for a network
Sugar reinforces when water is
removed



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Gluten and Starch

When baked, starch granules
absorb water, swell, and “set”

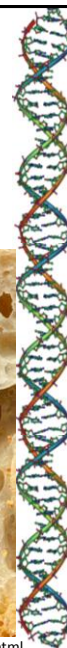
Starch pops
bubbles
Steam escapes



Image: <http://www.seriousseats.com/2011/06/the-food-lab-the-science-of-no-knead-dough.html>



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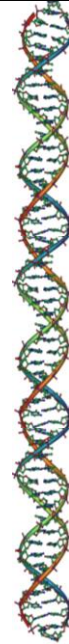


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Baking – Charles’ Law

How big do bubbles get?
 Assume a 1mL bubble @20°C
 heating up to 65°C

Race between expanding gas &
 stiffening gluten



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Steam in Baking

Phase changes

Steam transfers heat better

Keeps surface elastic longer

Glossy crust



Image: <http://tlc.howstuffworks.com/home/wash-and-dry-with-steam.htm>

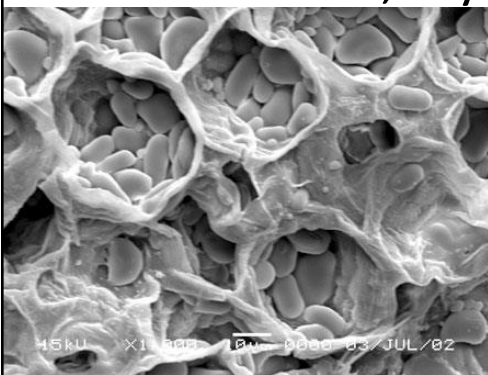


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Stale...

Changes in the starch

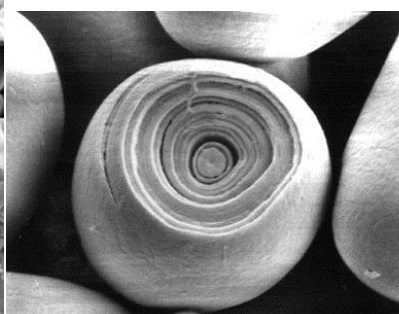
Gel loses water, crystallizes



15kV X1.00k 10um 0000 03/JUL/02

Image: http://www.aroid.org/gallery/held/starch_grains.php

Image: <http://sciencegirlsrock.wordpress.com/2011/05/30/women-of-outstanding-achievement/>



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Science to the rescue!

Stale bread can be “fixed”
 Consider the food molecules
 Starch – need to re-gel

Heat

Storage conditions



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Basic Bread

Ingredients:

3/4 cup warm water
 1 package active dry yeast
 1 tsp salt
 1-1/2 tbsp sugar
 1 tbsp vegetable shortening
 1/2 cup milk
 3 cups flour, approximately

Recipe: <http://breadbaking.about.com/od/yeastbreads/r/1loafbread.htm>



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