



Food Science and Nutrition

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Session Outline

Definitions...

- **Food science**
 - The classroom experience
- **Sensory perception**
 - Interactive in-class experiences



Two-fold purpose

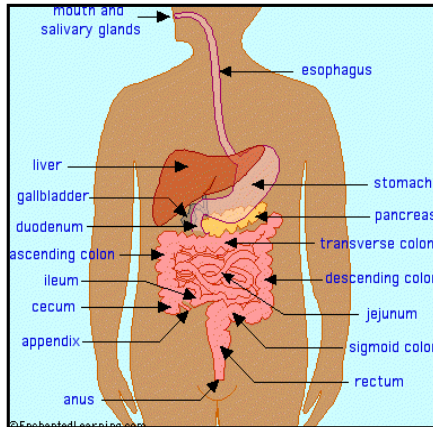
1. Define food science and discuss the goal of the food science classroom experience
2. Discuss sensory perception and its role in the interactive food science classroom

What is Food Science?



IFT

What *Food Science* is not...



Nutrition



Culinary Arts

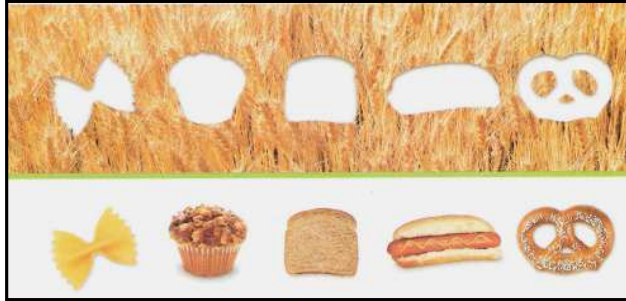
Nutrition --inter-relationship between food components, and their use by the body to sustain life and health

- Everything that happens to food once you swallow it!

Culinary Arts-- Food preparation as practiced by chefs

- Tends to be a more artsy, spontaneous approach to food innovation than is found in food science
- Trends ultimately embraced by food scientists, particularly as it related to food product development often have their origins in Culinary Arts

Goal of Food Science



“To transform perishable, unpalatable, or hardly edible raw materials into tasty, nutritious, stable and enjoyable foods.”

Flores, Food Tech 62 (5): 11

Flores– president of IFT

Same starting material can be converted into a number of products with different characteristics

- All are aimed at one or more targeted consumers

Food Scientists...

■ Study the makeup of food

- Physical
- Microbiological
- Chemical



■ Develop ways to **process, preserve, package, and store** food, according to industry specifications and government regulations.

Physical– viscosity, texture, flowability

Microbiological– presence of microbes and their positive and negative effects on food products

Chemical– molecular components and their involvement in rx

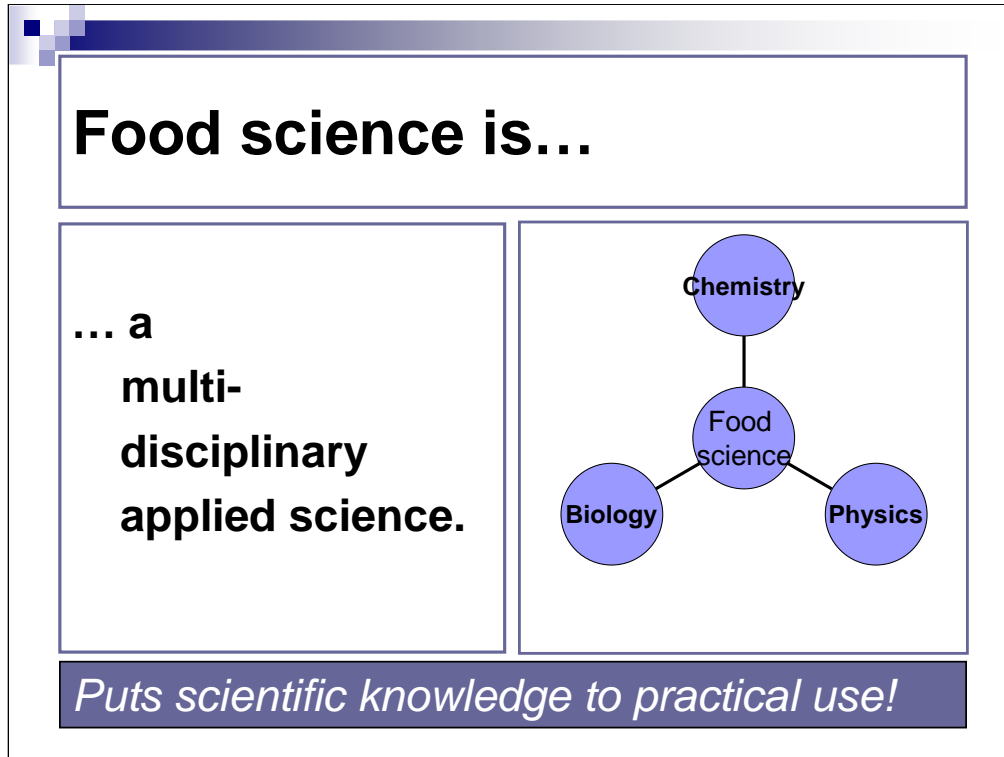
Process– to alter product form; to make it more palatable; the manufacturing of safe and palatable food

Preserve– causes and prevention of quality degradation

Package– selection of appropriate packaging to maintain quality and safety of the food product post-processing and throughout distribution

Store– specific conditions of storage and what are they

Food scientists are responsible for new products in the marketplace



Incorporates...

- Chemistry**– components of food and not just those added in food processing\
 - More basic– pro, fats, carbohydrates and largest constituent in foods– water
 - And their involvememnt in chemical rx
- Biology**– foods are plant or animal based
 - Microbiology**– spoilage micros
 - food-borne illness
 - food preservation/production techniques– yeast for example
- Physics**– cooking applies physics– heat
 - Processing**– involves physics and its related applied science– engineering

A food science course

- Presents science principles and uses food as a model to explain them
- is a good way to show that science is impt in everyday life

Food Science involves...

- **Experimentation**
- Experimentation involves **measurements**
 - Chemical measurements
 - Physical measurements
 - Physicochemical measurements
 - Sensory (human) measurements
- Reliable measurements involve the **Scientific Method**

Food science course differ from traditional food preparation unit in Family and Consumer Sciences courses

- Making informed consumer choices in the marketplace and skill development

It is a science-based course that involves

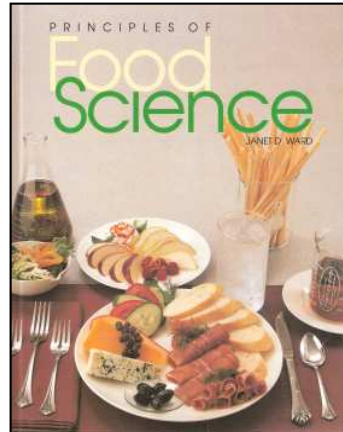
- Experimentation
- Measurements– collection of data
 - Array of techniques are used to collect data
- An approach that results in reliable measurements that then allow conclusions to be drawn is critical

Principle planning tool for this course is the scientific method

Food Science is...

- The study of the nature of food and the principles of its production, processing, preservation and packaging.

Ward, 2002



1. Definition
 2. Book cover– note the plate, forks, spoon, knife
 - Implies prep and consumption
-
1. Indeed, experiences outlined includes prep and consumption of products produced and their evaluation as a way to illustrate the scientific principles

Background: IFT definition...

Food Science is the discipline in which the engineering, biological, and physical sciences are used to study the nature of foods, the causes of deterioration, the principles underlying food processing, and the improvement of foods for the consuming public.

Food Science is...

a discipline concerned with all technical aspects of food, beginning with harvesting or slaughtering, and ending with its cooking and consumption.



Wikipedia, 2008

Food Science involves...

- **Experimentation**
- Experimentation involves **measurements**
 - Chemical measurements
 - Physical measurements
 - Physicochemical measurements
 - **Sensory (human) measurements**
- **Reliable measurements** involve the **Scientific Method**

What separates food science from food preparation...

1. **Collection and interpretation of data**

What separates food science from other science courses...

1. **Use of food as a model**
2. **Use of students and their senses as an instrument to collect data**

Sensory analysis is an important sub-discipline within food science

Sensory analysis in a nutshell

“Study of how food is perceived by the senses”

- A key aspect of food quality assessment
- Centered around measuring human perception and applying the learning



Quality assessment

- During product development
- During processing/ quality control
- Ultimately at home by the consumer

The sensory characteristics of food

- Appearance
- Flavor
- Texture
- *Overall Acceptability*



Appearance, flavor and texture are integrated into overall acceptability rating by a consumer, including students

If students are going to provide data on the sensory aspects of food

- Need an understanding of the underlying factors in sensory perception
- For most... taste is the inclusive term for overall acceptability

Flavor

Involves the basic senses of taste and smell



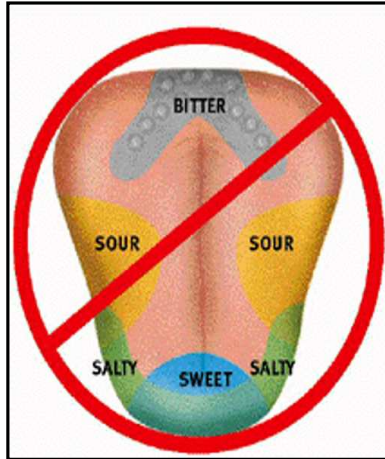
The interactions in the mouth of...

- basic tastes
- smell
- mouthfeel sensations

From a sensory perception point-of-view, taste is a component of flavor

Slide

Taste



- Properties perceived through the taste buds.

- Bitter, sour, salty, sweet and umami

“Essentially the basic tastes can be perceived on all loci where there are taste receptors” (Bartoshuk, 1993)

Taste

1. Limited to the gustatory system
2. 5 maybe 6 basic tastes– taste receptors have been identified for 5
3. Tongue map bogus
4. Taste buds located on roof of mouth (soft palate), cheeks, back of throat
5. Tendency to confuse sour and bitter
6. Not sure what umami is

Foods high in umami



- Peas
- Parmesan cheese
- Bonito flakes
- Shiitake mushrooms
- Sardines
- Tomato juice
- Dried seaweed (nori)
- Green tea
- Soy sauce
- Fish sauce

If , you eat:

1. Soy sauce or Worcestershire sauce on everything
2. Mushrooms are your vegetable of choice
3. And Parmesan cheese should be its own food group

Then you're a closet umami fiend

Umami elicits a savory, meaty, brothy taste note

Common in ingredients in Asian cookery

Long identified as a basic taste in Japan and China

- Why not US?
- Thought we could describe with 4 basic tastes, so we did

The 5th basic taste modality-- Umami or savory

■ Detection requires...

- Free glutamic acid

■ Perception effects...

- Enhances inherent flavor
- Adds...
 - fullness
 - complexity
 - balance

■ Levels in food are affected by...

- Stage of ripeness
- Aging
- Drying
- Fermentation

■ All processes... breakdown foods into smaller units

Umami is elicited by a specific chemical compound

Like long known basic tastes...

•Sucrose– sweet

•NaCl– salty

•Citric acid– sour

•Caffeine– bitter

Umami is elicited by free glutamic acid– amino acid– building block of protein

•MSG developed as a commercial source of this compound that can be added directly to food.

Perception effects on foods is similar to salt

Levels inherent in food products different with harvesting and processing conditions

•Ripening— fruits and vegetables

>>> ripe tomato has 10X umami as unripe

>>>Highest levels of free glutamic acid when hyper-fresh and perfectly ripe

•Aging– red meats, cheese

•Drying– fish, mushrooms

•Fermentation-- soy, fish, Worcestershire sauce, vegemite

>>> beer, wine

The 5th basic taste modality– Umami or savory

- Sampling...
Miso soup



Discuss taste perception

Smell

The perception of volatiles by the cells in the nasal area

- **Odor**– sniff, perceived through nose
- **Aromatics**– volatiles perceived as food is masticated in the mouth

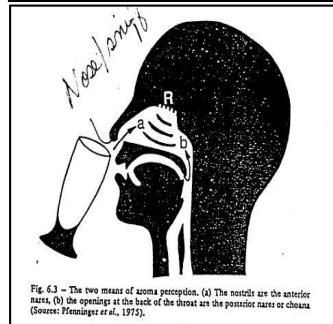


Fig. 6.3 – The two means of aroma perception. (a) The nostrils are the anterior nares. (b) the openings at the back of the throat are the posterior nares or choana. (Source: Fenneliger et al., 1973).

Smell is second component of flavor perception.

Odorants are small volatile molecules

Very diverse chemical structures

More than 10,000 of aromas/odors can be detected by humans

Odors– directly perceived by sniffing

Aromatics...Volatiles are released by 1) mixing with saliva, 2) manipulation with tongue.

•Both are perceived via receptors in the olfactory region – “R”

Mystery Granules Procedure

1. Uncap vial at arm's length
2. Manipulate tongue to stimulate saliva flow
3. Pinch nose tightly
4. Tip head back and stick out tongue
5. Pour granules on tongue and manipulate with tongue

Think– what do I perceive now?

Close mouth, release nose and inhale

Think– what do I perceive now?



Mystery Granules are 1 tsp cinnamon per 1 cup granulated sugar

Can use small souffle cups rather than vials

Mystery Granules

- What is the **basic taste**?

SWEET!

- What is the **aromatic**?

CINNAMON!



Basic taste– when nose was tightly pinched

Nose open– cinnamon– aromatic

Illustrates the integration of gustatory and olfactory systems to generate flavor

Mouthfeel

Sensations perceived by the nerves in the skin of the mouth cavity.

■ Thermal

Hot



Cold

■ Chemical

Warm



Cool

Third aspect of flavor

Thermal: Serving temperature influences: flavor, texture perception

Chemical: Ex. Peppermints, carbonation, alcohol. May contribute to desirable characteristics.

Mouthfeel

Sensations perceived by the nerves in the skin of the mouth cavity.

■ Burning



■ Astringent



Burning– chemical irritant

Actually stimulates the pain receptors

Salsa-- The pain that pleases

- capsaicin in hot peppers
- Peperine in black pepper
- Other common foods– ginger, cinnamon

Astringent--drying, puckering sensation in mouth

tea, red wine

Often confused with bitterness

Bitter compounds may be astringent

Trigeminal sensations

Sampling...

- Crystallized ginger
- Cinnamon Altoids



Mouthfeel sensations are due to stimulation of the trigeminal nerve

Nerve has 3 branches

- tongue
- Palate
- nose

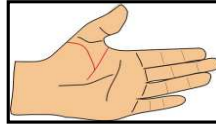
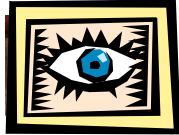
Trigeminal verbal descriptors

- Pungent
- Burning
- Painful
- Sharp
- Astringent
- Furry
- Scratching
- Tickling
- Prickling
- “Sneeze’
- Cool
- Warm

(Laska, 2001)

Texture

- Involves the senses of sight, touch and hearing. The sense of touch involves both the skin and the muscles.



- Perception of the structure or inner make-up of foods...
 - **Mechanical Characteristics**
 - **Geometrical Characteristics**
 - **Moisture and Fat Influences**

Mechanical: reaction of food to stress-- hardness, firmness, stickiness, slickness, toughness. In the mouth, stress is applied by the teeth; tongue is the manipulator (hands).

Geometrical: related to size, shape and arrangement of particles within a food: grittiness, flakey, lumpy, stringiness

Moisture and Fat: influences perception of both mech and geometrical.

Texture Terms- Mechanical Characteristics

Primary	Secondary	Popular Terms
hardness	-----	soft > firm > hard
cohesiveness	brittleness	crumbly > crunchy > brittle
-----	chewiness	tender > chewy > tough
-----	gumminess	short > mealy > pasty > gummy
viscosity	-----	thin > thick
springiness	-----	plastic > elastic
adhesiveness	-----	sticky > tacky > gooey

Texture Terms– Geometrical Characteristics

Particle Size and Shape		Particle Shape and Orientation	
smooth	grainy	flaky	foamy
fine	coarse	fibrous	puffy
powdery	lumpy	stringy	crystalline
chalky	beady	pulpy	glassy
gritty	mealy	cellular	gelatinous
		aerated	spongy

Texture— Fat and Moisture

Moisture Content			Fat Content		
wetness			oiliness		
moisture release			greasiness		
rate of moisture release					
moisture absorption					
Popular terms related to mouthfeel and mouthcoating					
dry	wet	watery	oily	waxy	creamy
moist	juicy		greasy	slimey	mushy

Both impact ease with which you can manipulate products in mouth

- Fat content

- Oily/ greasy – tends to be related to slickness and state– solid vs liquid
- Also impact moisture perception through the stimulation of saliva flow
 - Perceived as juiciness

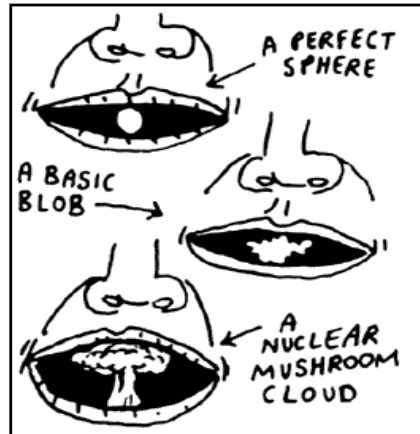
- Moisture content

- Wetness- amount of moisture present
- Moisture release– moisture released during chewing
- Rate of moisture release– during mastication
- Moisture absorption– bolus absorbs moisture from the saliva– think crackers

Texture



- Perception of texture changes with mastication
- Sequential...
 - initial impression
 - first bite
 - during chewing
 - residual phase



Perception changes with mastication-- sequential.

EAT A CRACKER AND THINK ABOUT THE STEPS

When consumers are asked why they dislike a product, often give a textural reason.

- Like descriptors-- tender, smooth, flakey, creamy, crisp, chewy, crunchy.
- Dislike descriptors-- slimy, greasy, sticky, rubbery, lumpy, tough, string

•Acceptability of various textures related to...

Age teeth erupt

Development of mouth and jaw muscles

y.

Appearance

A visual manifestation of color, gloss, size and shape

■ Determines your initial opinion of a food product...

- Flavor Recognition
- Perceived Flavor Intensity
- Initial Assessment of Texture



Appearance– do first but talk about last because impact perception of both flavor and texture

- We assess texture first based on appearance (cracker)
 - Beverages– thickness
 - Snack mix-- geometrics Dryness; crispness
- We make a tentative flavor identification based on appearance.
 - And even assess small differences in flavor– brown toast vs white toast

Appearance

- **Sampling**– virgin Jello shots
- Make Jello and manipulate the color
 - Lemon– green
 - Orange– red
- Sample and identify the flavor present



Tend to identify green as lime
Red as cherry

Others also possible; best done with at least 4 manipulated colors.

If asked to assess quality then often rate the quality as poor when color rather than flavor is used to identify and the identification is wrong

“IS THIS FOOD ACCEPTABLE?”



■ Consumer decision-making...

- 60% Food Quality
- 40% Other Factors
 - Health
 - Nutrition
 - Religion
 - Ethnicity
 - Economics
 - Advertising
 - Lifestyle
 - Regional influence

Food Quality

- Sensory major component
- Others– safety and nutritive value

Taster status– individual differences

Are you
or
are you not
a
supertaster?



Even when we know the terminology and everyone is talking the same language

- There are individual differences that must be recognized
- Each of us lives in our own taste and smell world
 - It's genetic and anatomical
- Are you or are you not a supertaster?

One last determinant of sensory perception of food– Taster Status

Identification of Supertaster Status

- **Sensitivity to:**
 - PTC– phenylthiocarbamide
 - PROP– 6-n-propylthiouracil
- **US population is:**
 - 25% nontasters
 - 50% medium tasters
 - 25% supertasters
- **Testing method:**
 - 1 suprathreshold concentration



PTC– phenylthiocarbamide; PROP– 6-n-propylthiouracil

PTC and PROP are assessment tools only
Compounds are not in food

Suprathreshold levels– levels much higher than it would take to just perceive
it's presence

Supertaster??



- Bag filter paper strips in coded bags
 - Control (plain) (orange dot)
 - PTC (green dot)
- Provide... water, cracker, carrots/apple as palate cleansers



Supertaster??

Procedure...

1. Wet tongue
2. Place appropriate strip on tongue for 20 sec
3. Record response on scorecard



Scorecard for Taste Test					
Paper 1 Orange Dot					
Taste Present: _____	No Taste	Slight Taste	Moderate Taste	Strong Taste	Very Strong Taste
Take a sip of water --- repeat with paper 2					
Paper 2 Green Dot					
Taste Present: _____	No Taste	Slight Taste	Moderate Taste	Strong Taste	Very Strong Taste
Take a sip of water, bite of cracker or carrots if you would like to clean your mouth.					

Supertaster??

Scorecard for Taste Test					
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Take a sip of water, bite of cracker or carrots if you would like to clean your mouth.					

Interpretation...

• Paper 1 is the control-- should only taste like paper

• Paper 2 is PTC paper-- bitter

• Non-taster-- no taste, slight taste

• Medium taster-- moderate or strong taste

• Supertaster-- very strong taste (strongest taste imaginable)

Papers are available from:

Flinn Scientific Inc

PO Box 219

Batavia, IL 60510

www.flinnsci.com

1-800-452-1261

Order Numbers:

Control paper: AP7990

PTC paper: AP7989

Bitterness perception-- sensitivity

- **Genetically linked**
- **Women more likely to be sensitive**
- **Asian, African, Native American heritage > than European heritage**
- **Related to differences in taste bud density**

(Duffy and Bartoshuk, 2000; Bartoshuk, 1993)

PTC/PROP sensitivity

- More sensitive to all basic tastes
- Affects perception of other food components
 - With increased PROP sensitivity...
 - Liking of sweet and high-fat foods decreased with among women; increased among men
 - Increased burn from capsaicin
 - Increased warmth from alcohol
 - Frequency of consumption of dark green vegetables, grapefruit, black coffee decreased

(Duffy and Bartoshuk, 2000; Bartoshuk, 1993)

Increased taste buds and surrounding trigeminal innervation



Final activity to integrate it all and illustrate importance of sensory perception in not only food quality but also food identification

Pureed Product Identification-- Demo

1. **Blindfold student**
2. **Open food container**
3. **Present to nostrils**
Identify by smell
4. **Present to mouth**
Identify by taste + smell
5. **Cleanse palate**
 1. *Water*
 2. *Crackers*
 3. *"X" cup/ napkins*

- green beans
- squash
- rice
- chicken
- pureed cottage cheese



Observers can write down guesses based on appearance– really only color clues

Blindfolded student must rely on sense of smell (odor) alone or taste and smell (odor and aromatics); textural and appearance clues have been removed

Student should be allowed to expectorate in the X cup directly or in the napkin

Water should be room temperature

Crackers should be unsalted top saltines

Other baby foods can be used but important not to use mixtures and be sure to use only the foods with very smooth consistency



Food science is a great way to sell science and make it meaningful to students who really can't figure out why they needed any science course.