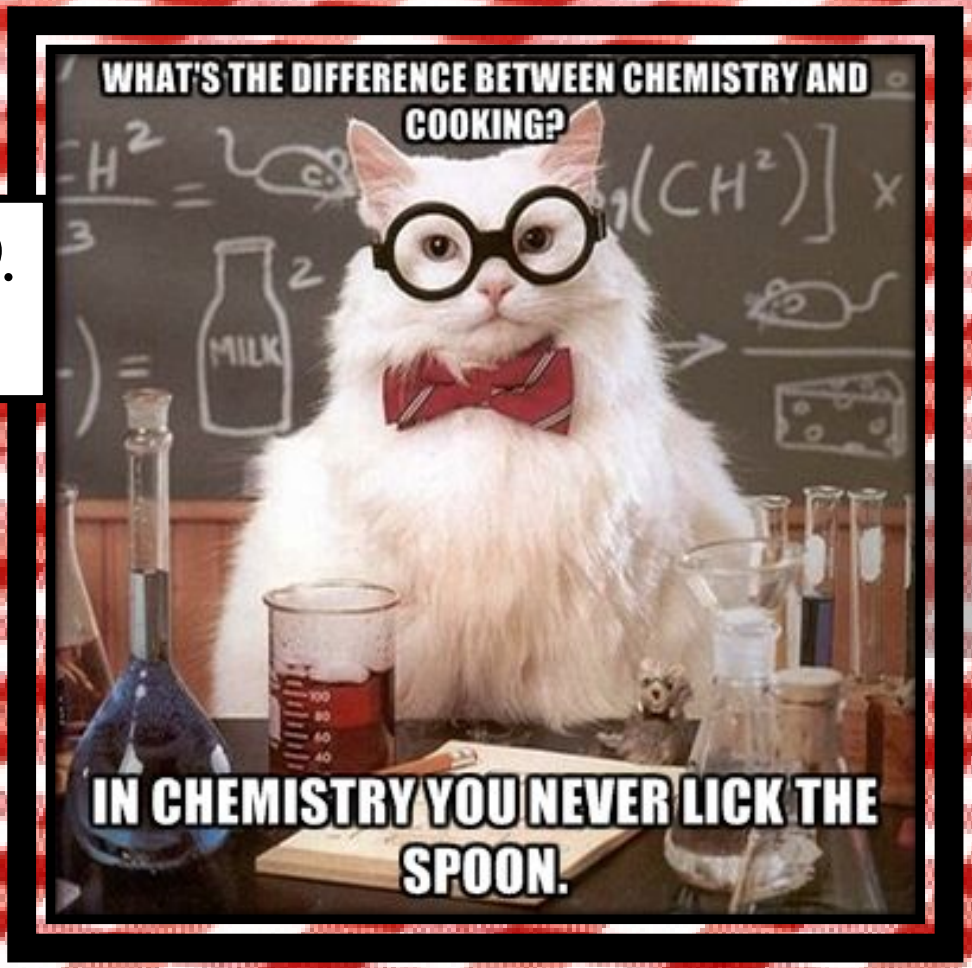
Culinary Chemistry: A Campus Cuisine Cookoff

MSUB Library Lecture series
Spring 16

Michele McMullen R.D.
Dr. Matt Queen




EGGS!
EGGS!
EGGS!
EGGS!
EGGS!
EGGS!
EGGS!

EGGS: Anatomy

Figure 12-1 p252

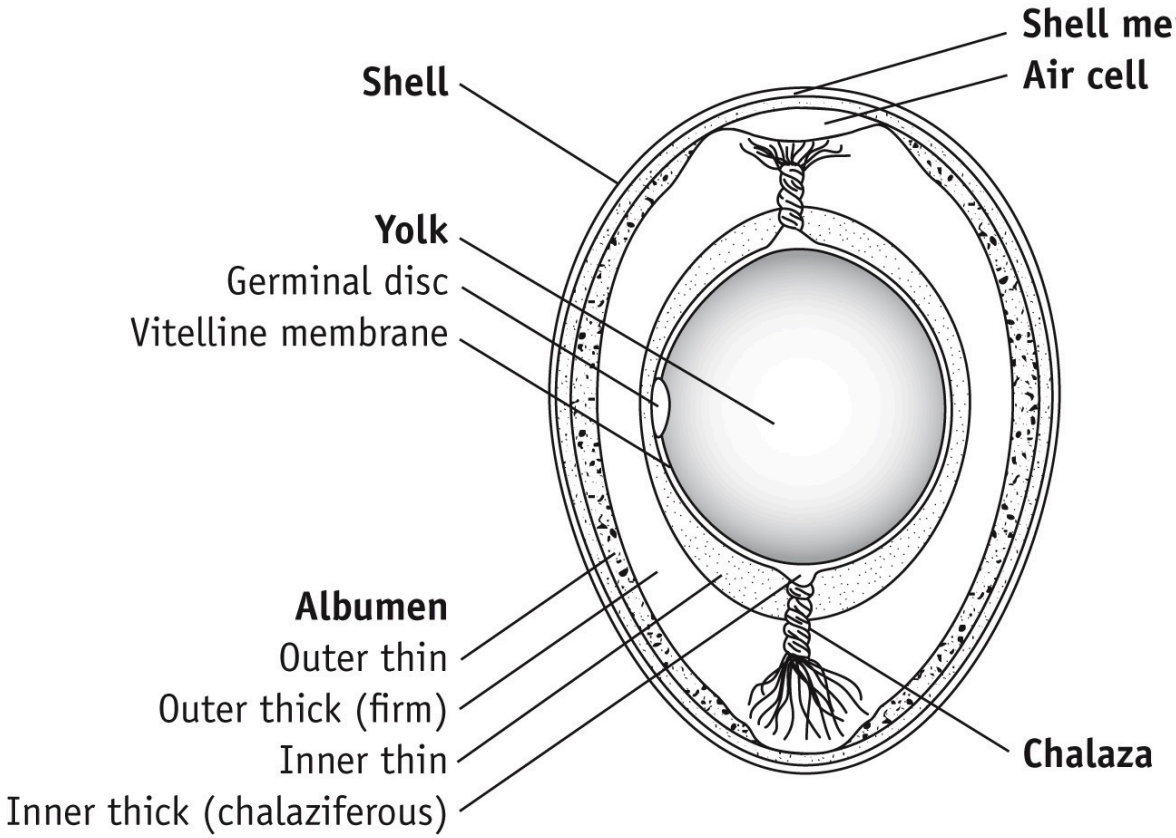


Figure 12-1 p252

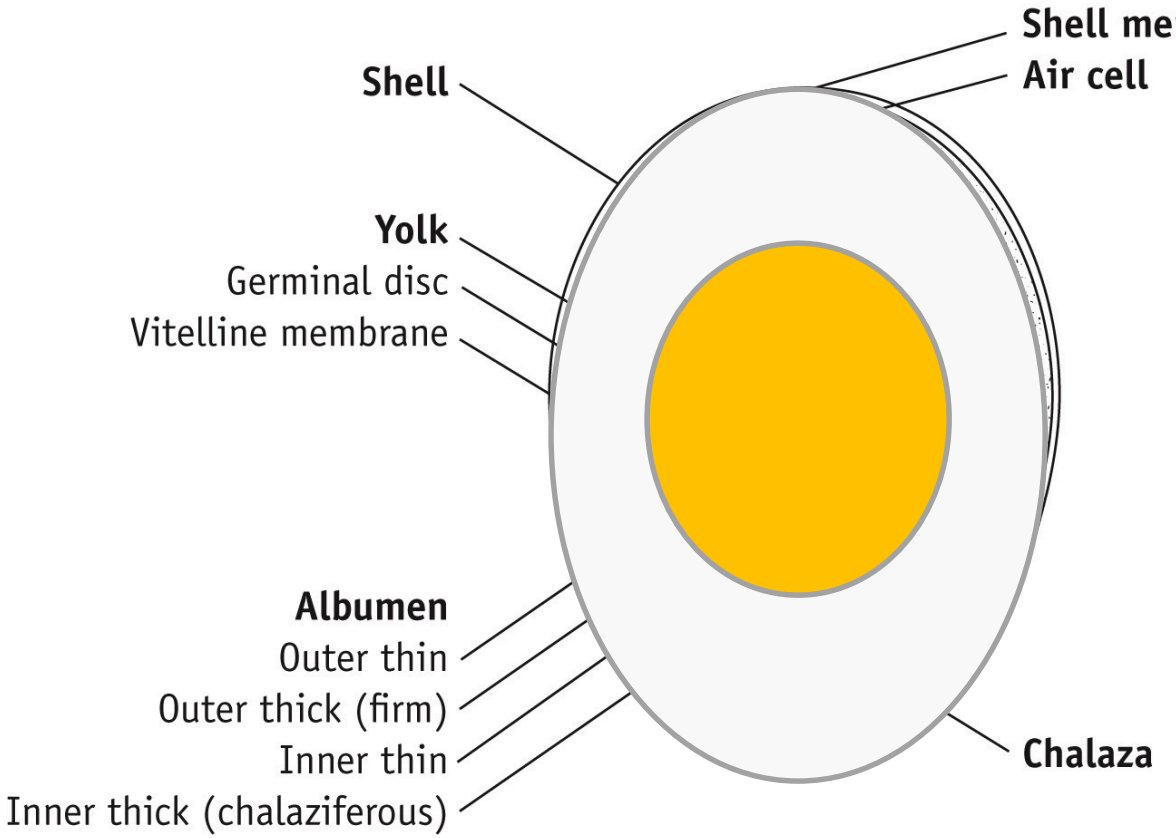
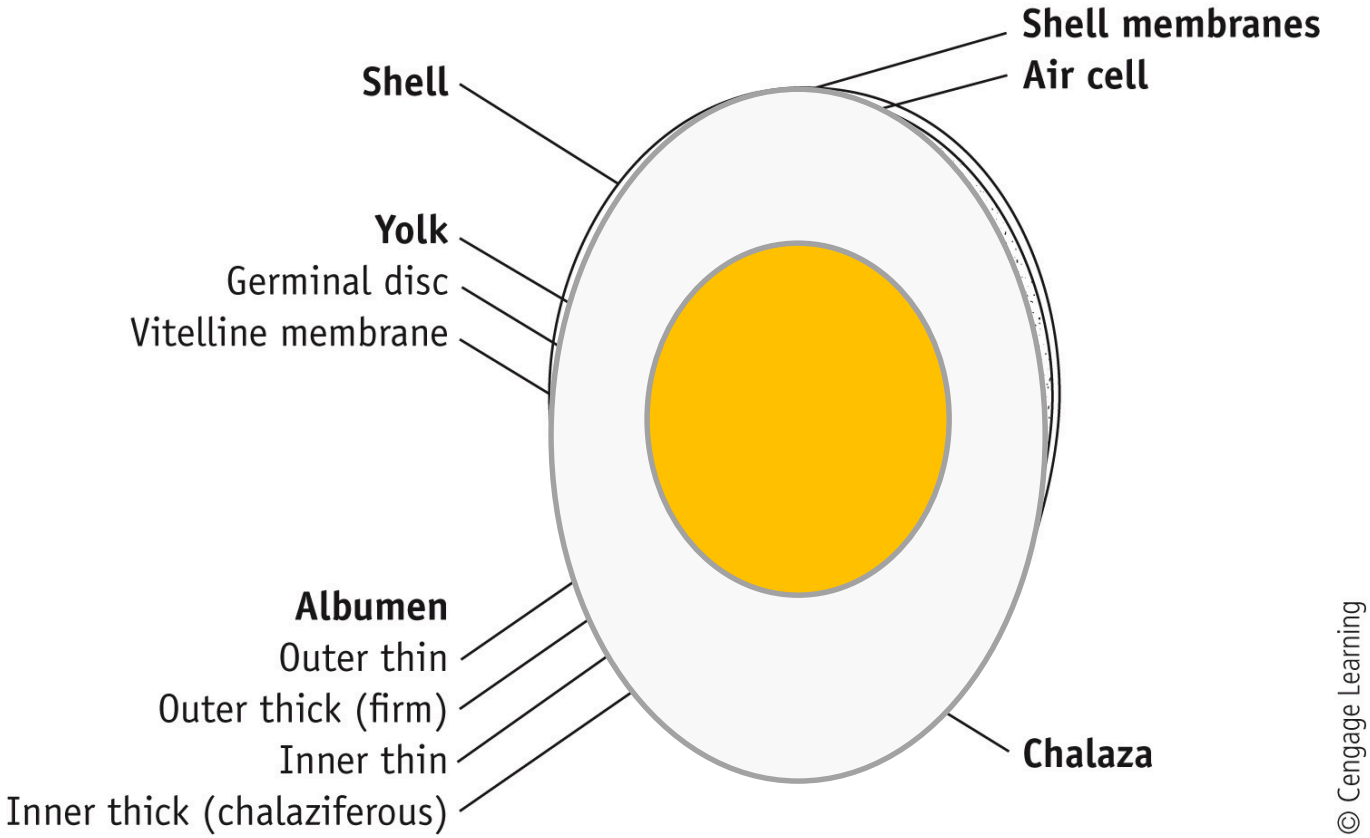


Figure 12-1 p252

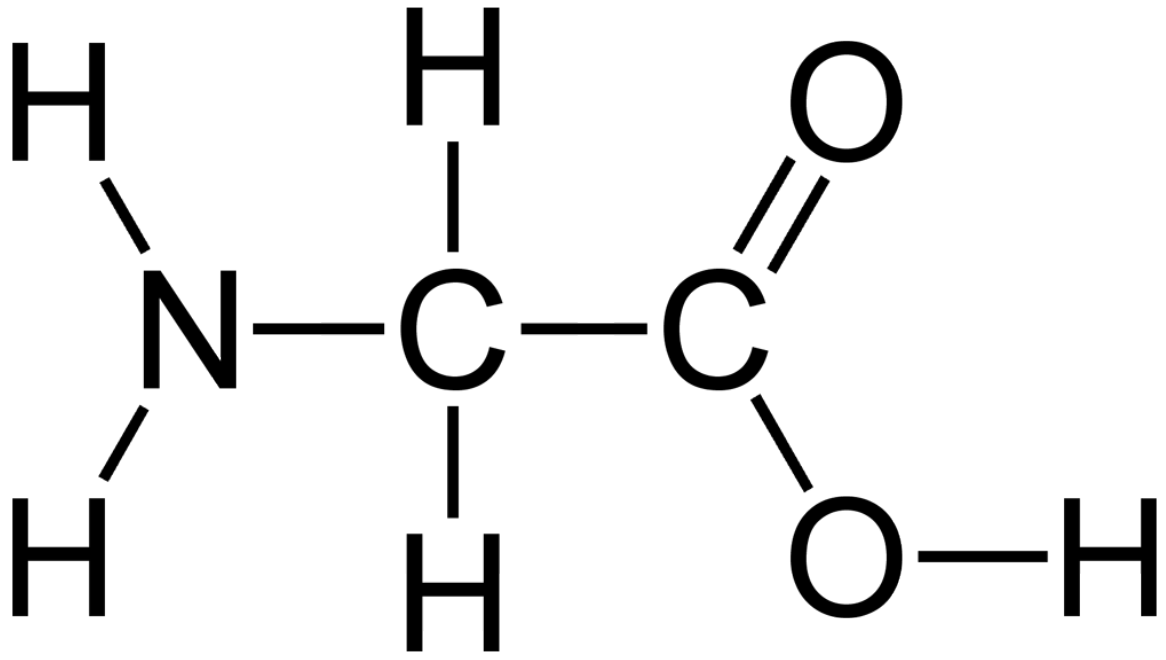


Component	Whole Egg	White	Yolk
Weight	55g	38 g	17 g
Protein	6.6 g	3.9 g	2.7 g
Lipids	6 g	0 g	6 g
Calories	84 kcal	20 g	64 g

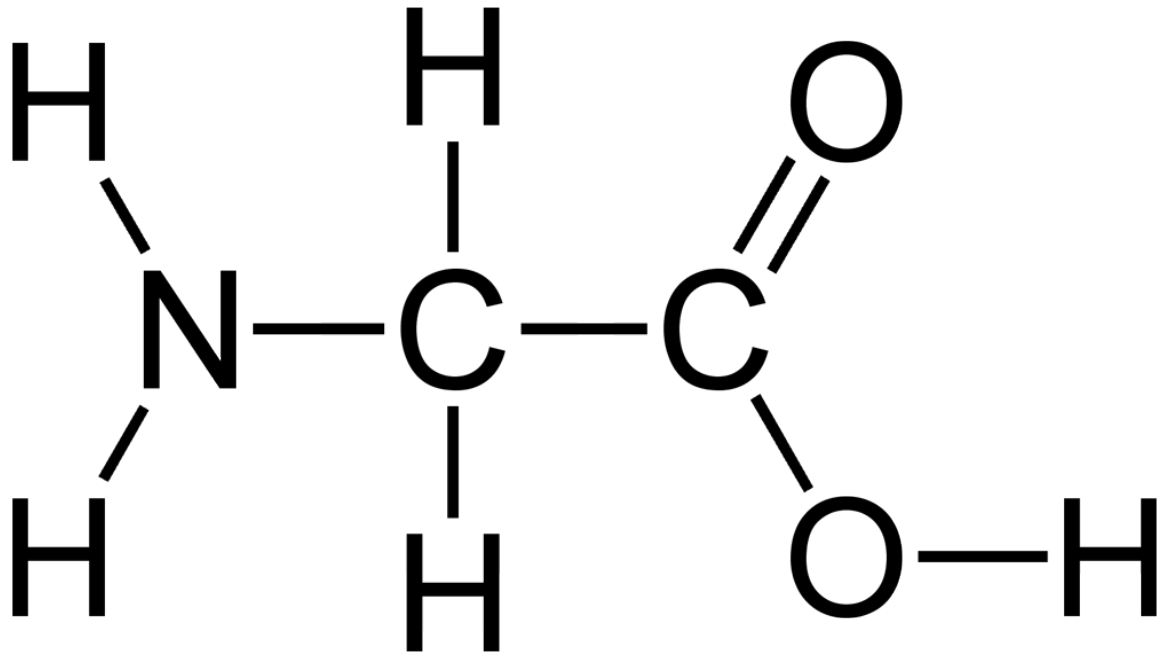
What are proteins and lipids?

What are **proteins** and lipids?

What is this?



What is this?



Glycine

Generic Amino Acid

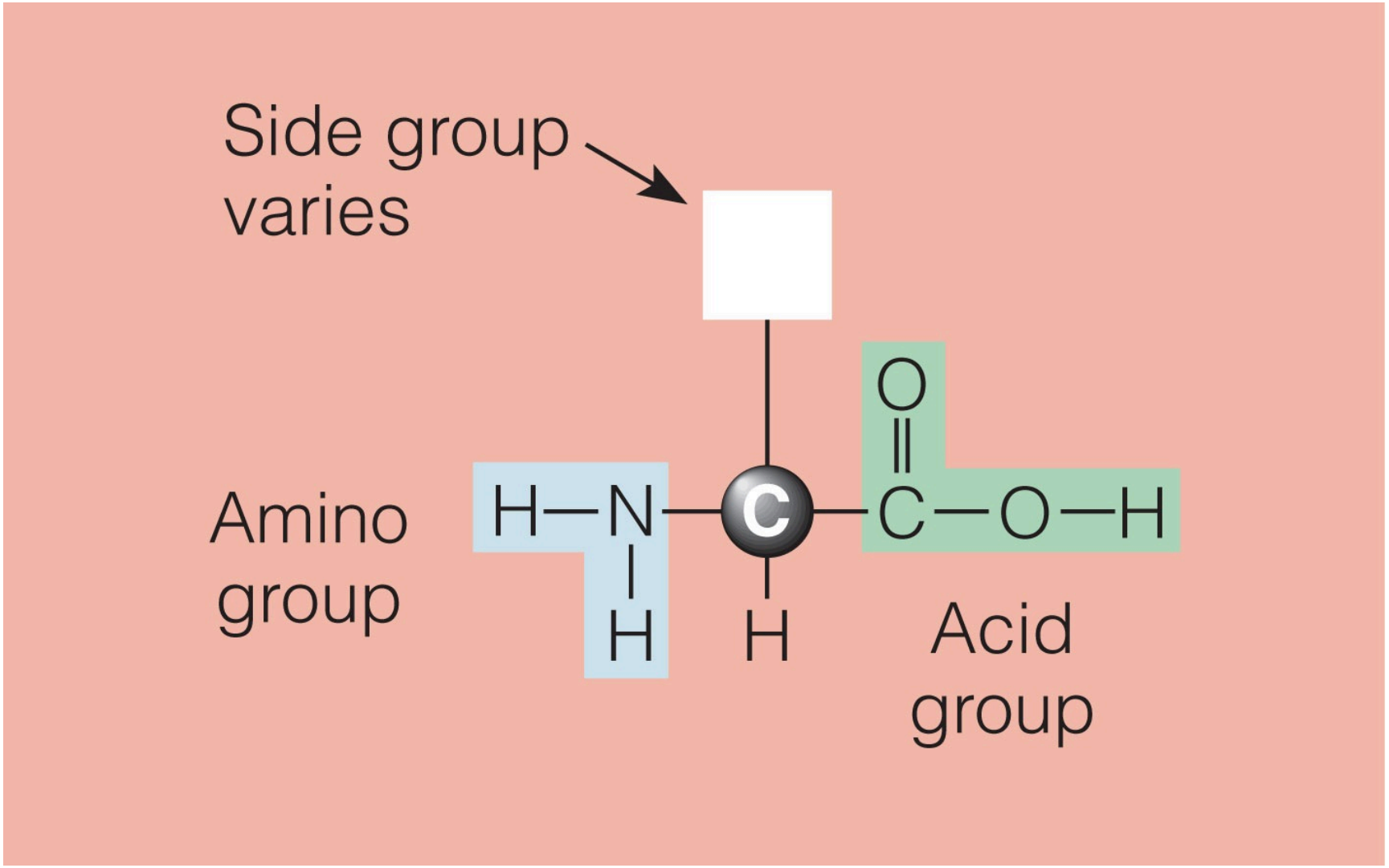


Figure 6-1 p168

The side chains determine the properties of the amino acids

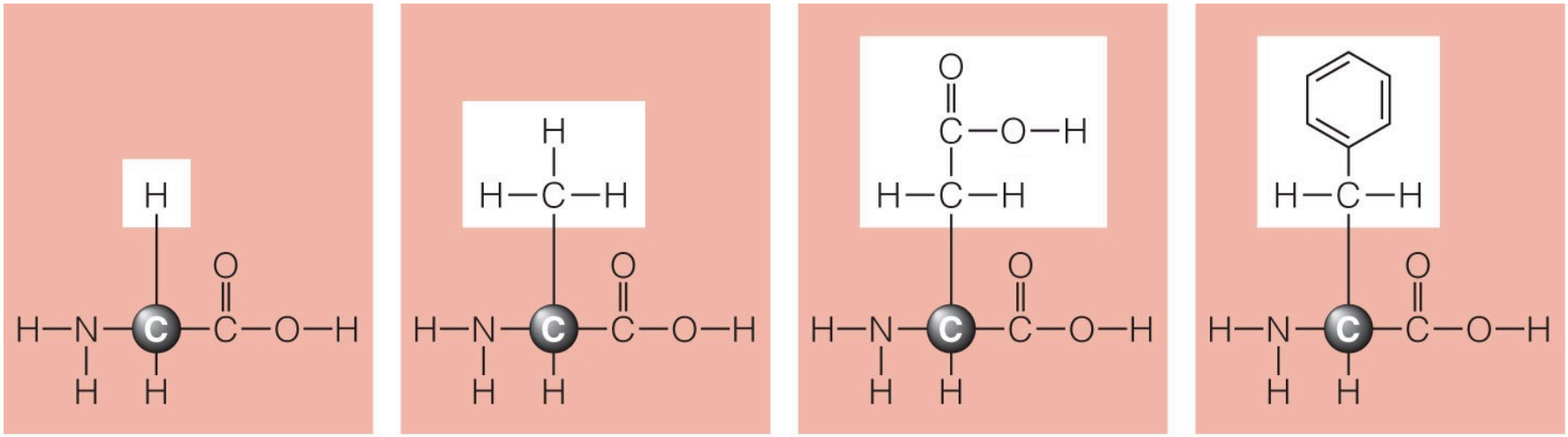
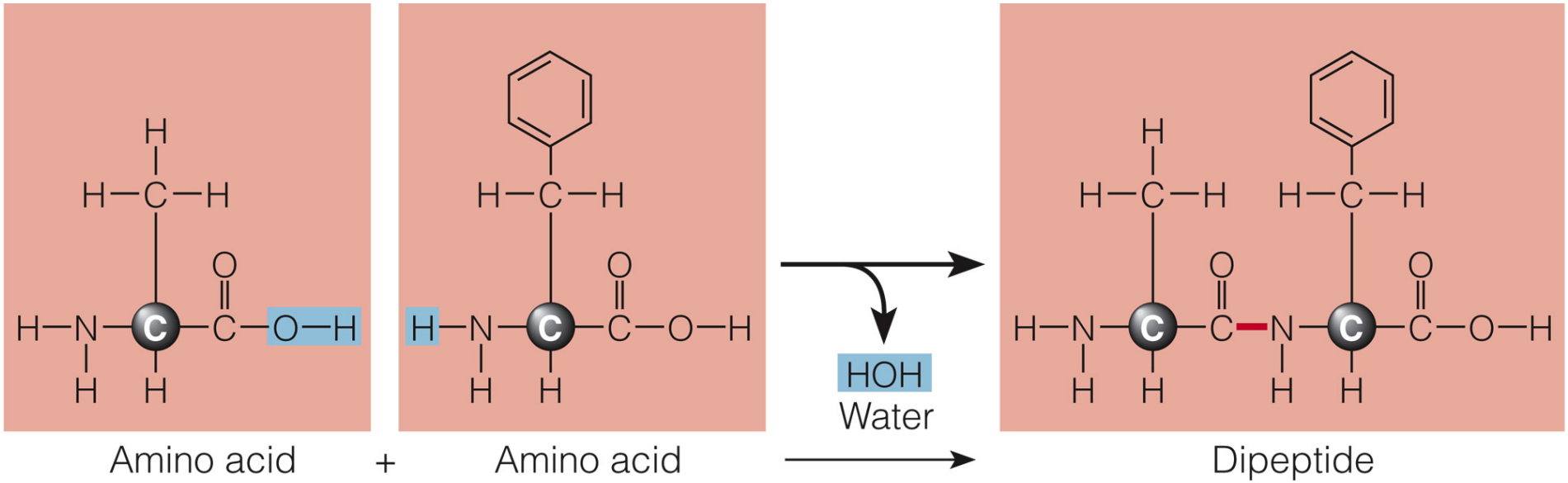


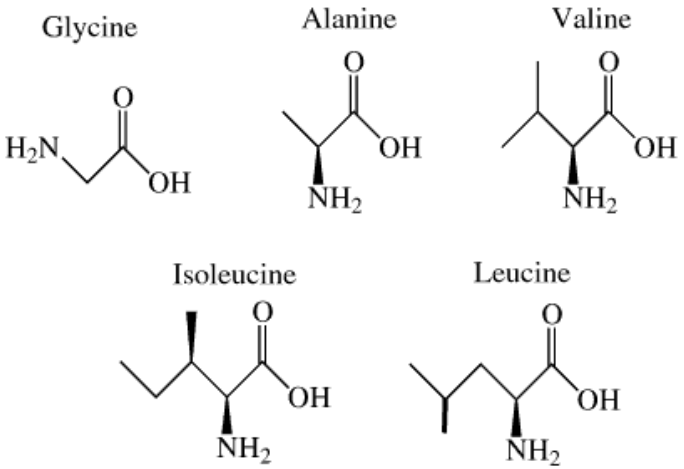
Figure 6-2 p169

Amino acid chains form peptides

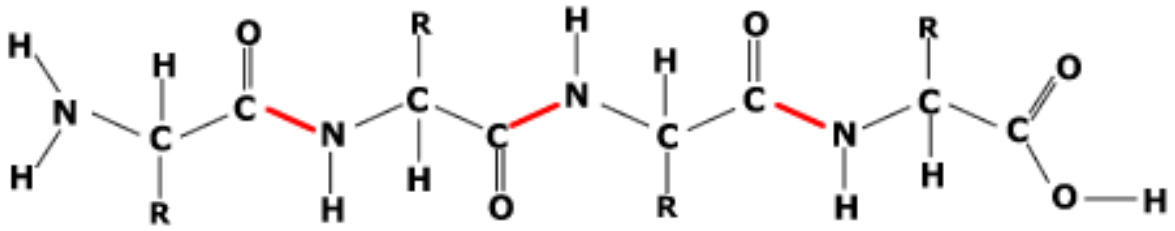


An OH group from the acid end of one amino acid and an H atom from the amino group of another join to form a molecule of water.

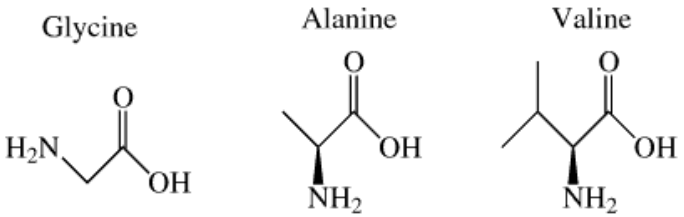
A peptide bond (highlighted in red) forms between the two amino acids, creating a dipeptide.



Amino acids



Polypeptide

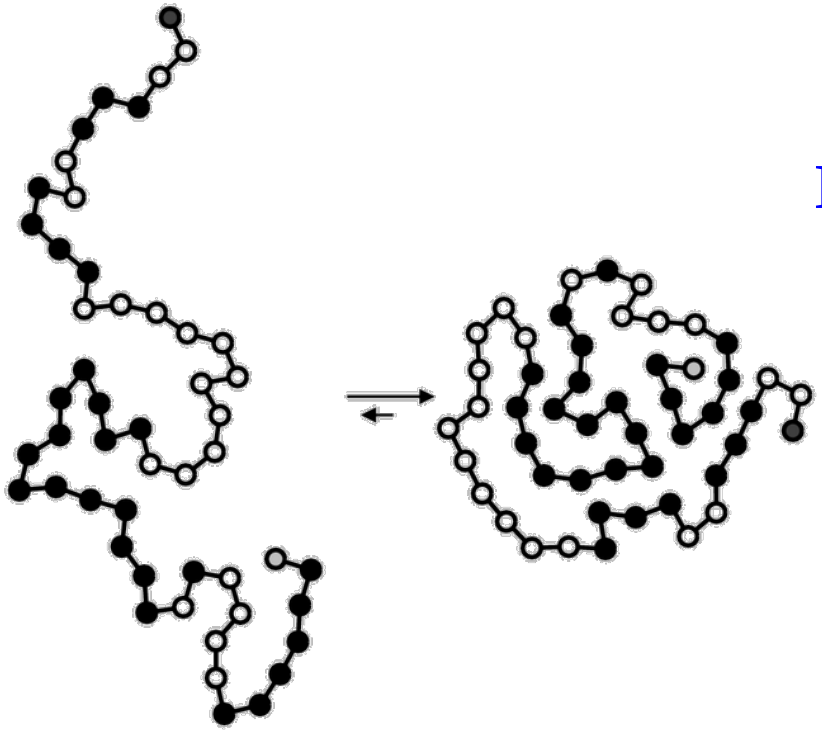


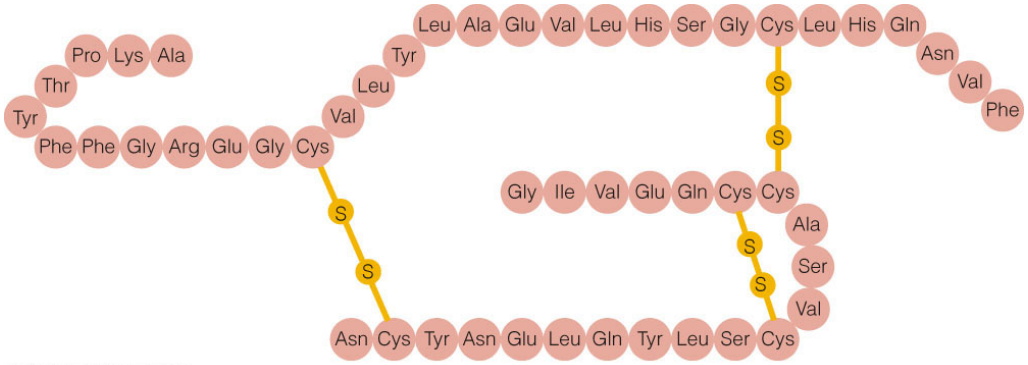
Amino acids

Amino Acids and Protein Folding

polar
(hydrophilic)
LOVES WATER

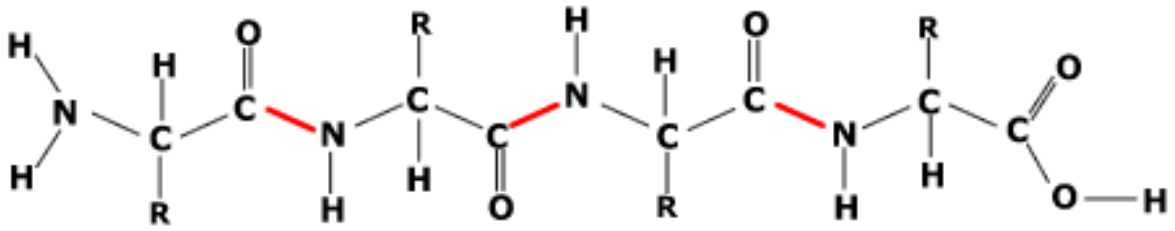
arginine
asparagine
aspartic acid
glutamic acid
glutamine
histidine
lysine
serine
threonine
tyrosine



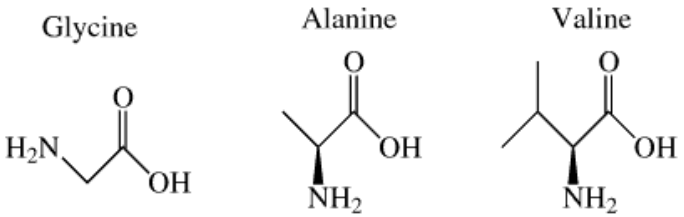


nonpolar
(hydrophobic)
HATES WATER

alanine
cysteine
glycine
isoleucine
leucine
methionine
phenylalanine
proline
tryptophan
valine

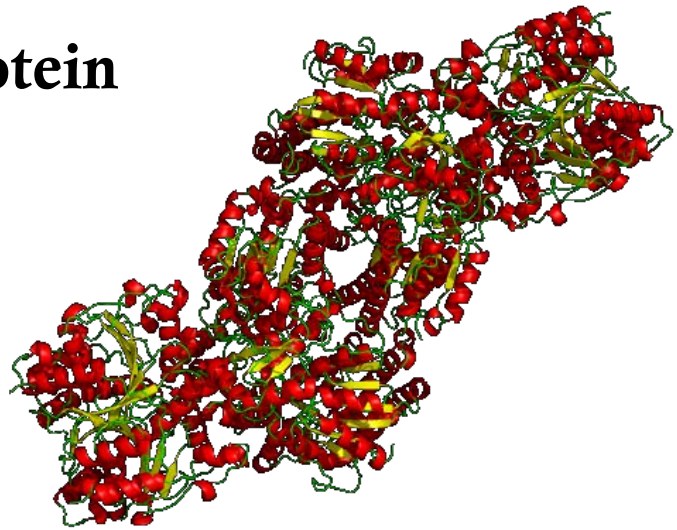


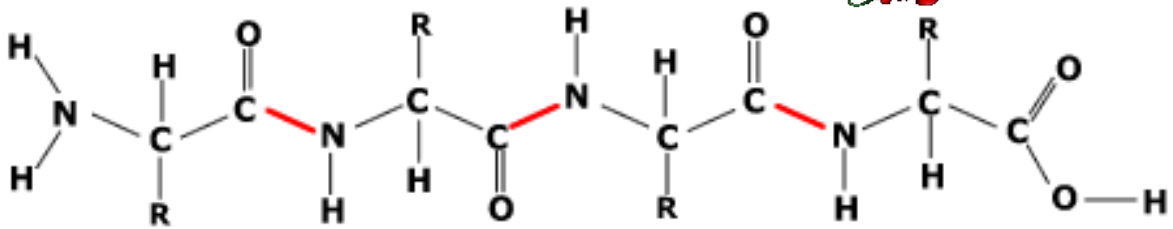
Polypeptide



Amino acids

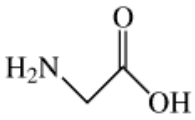
Protein



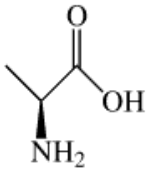


Polypeptide

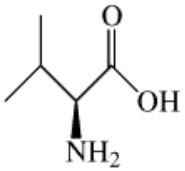
Glycine



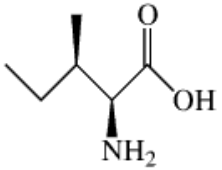
Alanine



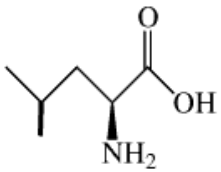
Valine



Isoleucine



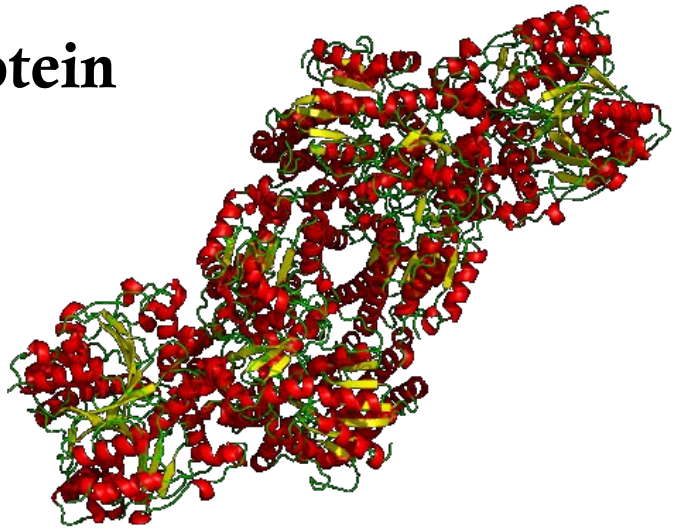
Leucine

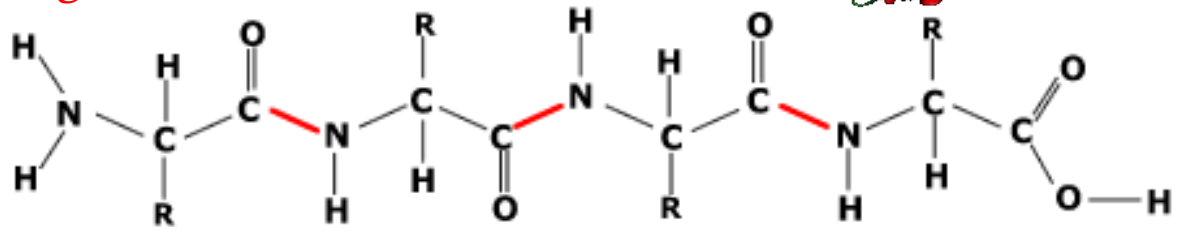


Amino acids

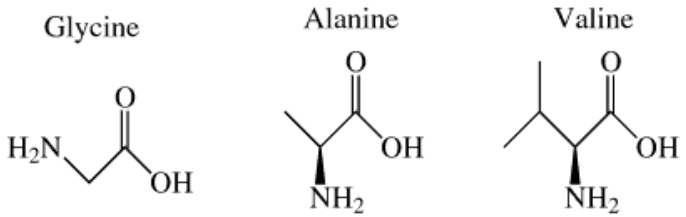
6 google image for “weird human”

Protein



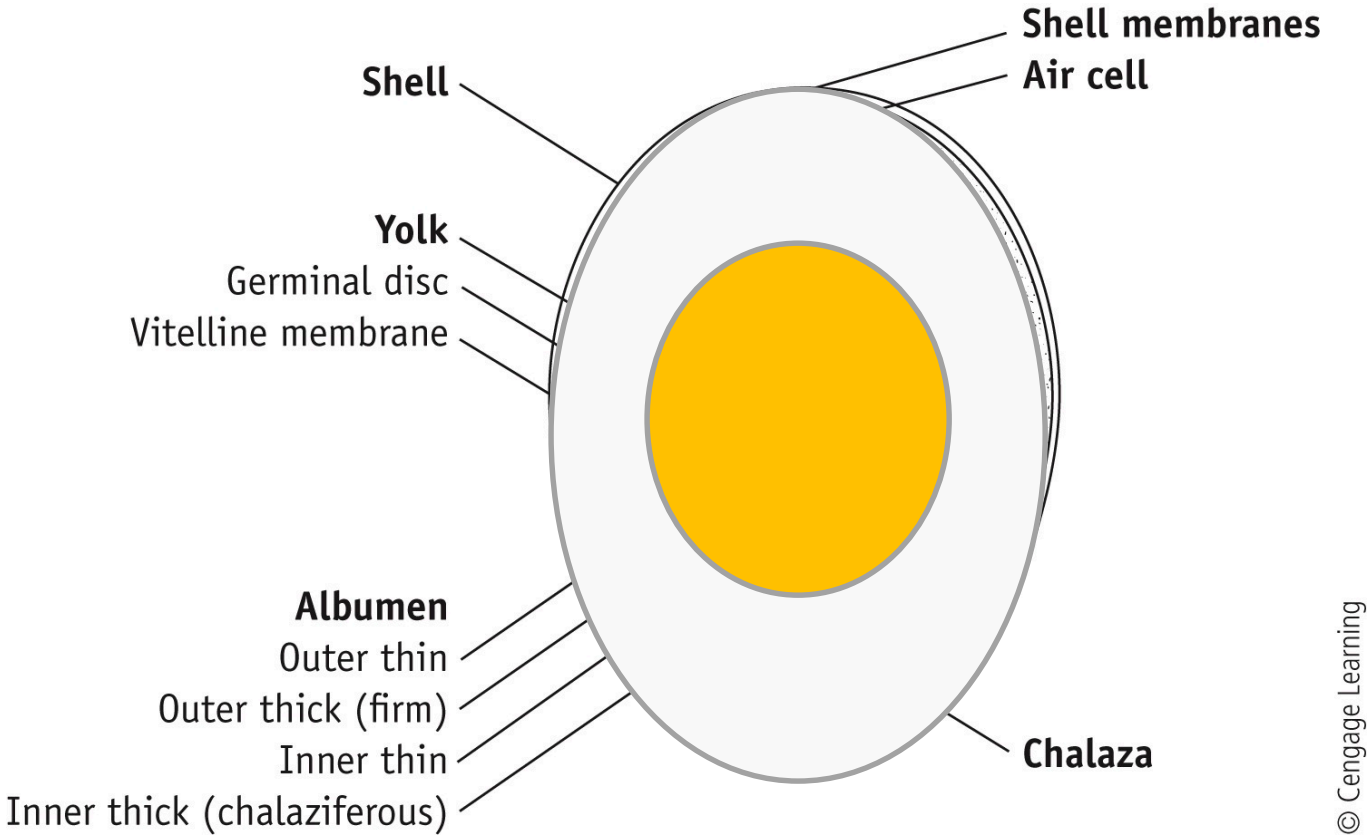


Polypeptide



Amino acids

Figure 12-1 p252



Component	Whole Egg	White	Yolk
Weight	55g	38 g	17 g
Protein	6.6 g	3.9 g	2.7 g
Lipids	6 g	0 g	6 g
Calories	84 kcal	20 g	64 g

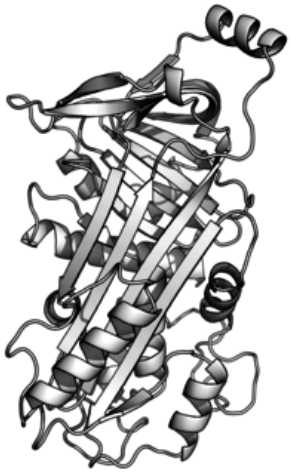
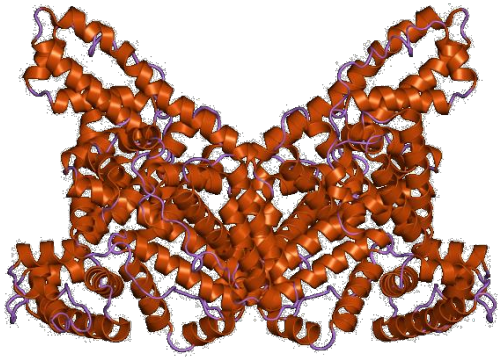
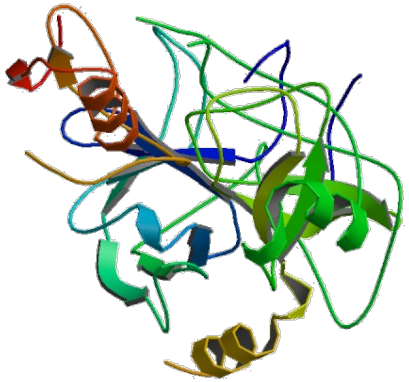
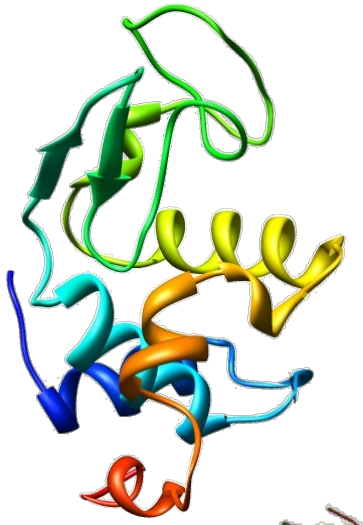
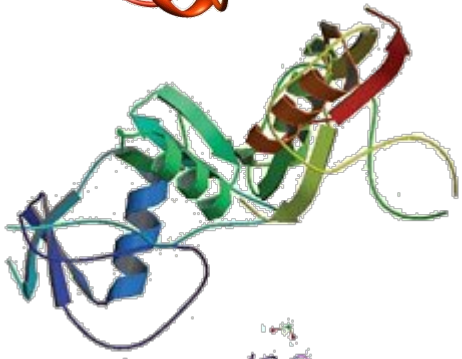
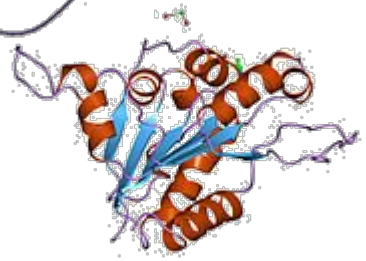
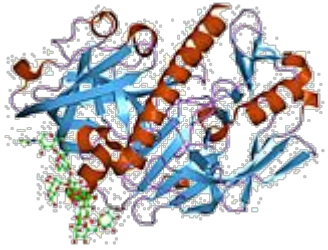
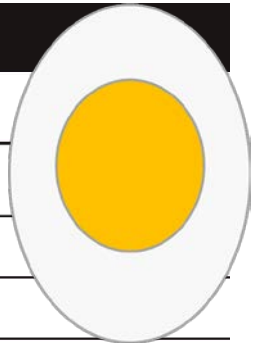








TABLE 12-1 Protein Content of Egg White



Protein	Amount (%)*	Properties
Ovalbumin	54	Denatures easily
Conalbumin	13	Antimicrobial, complexes iron
Ovomucoid	11	Inhibits enzyme (trypsin)
Unidentified	8	Mainly globulins
Lysozyme	3.5	Antimicrobial
Ovomucin	1.5	Viscous, reacts with viruses
Flavoprotein	0.8	Binds riboflavin
Proteinase inhibitor	0.1	Inhibits enzyme (bacterial proteinase)
Avidin	0.05	Binds the B vitamin biotin (raw egg white only)

*Expressed as a percentage of the total protein content of the egg white.

What are proteins and **lipids**?

The Family of Lipids

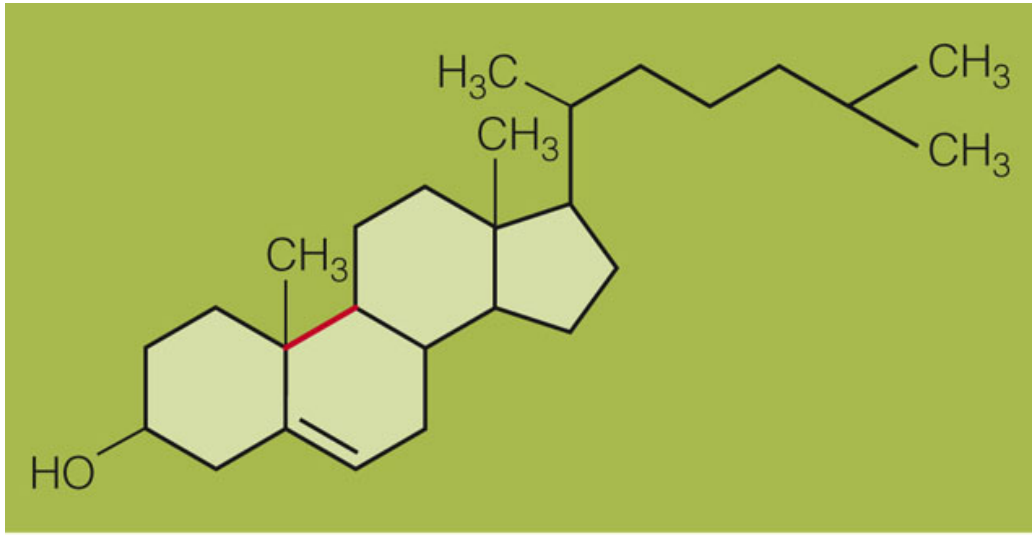
HYDROPHOBIC (HATES WATER):

- Sterols
- Triglycerides

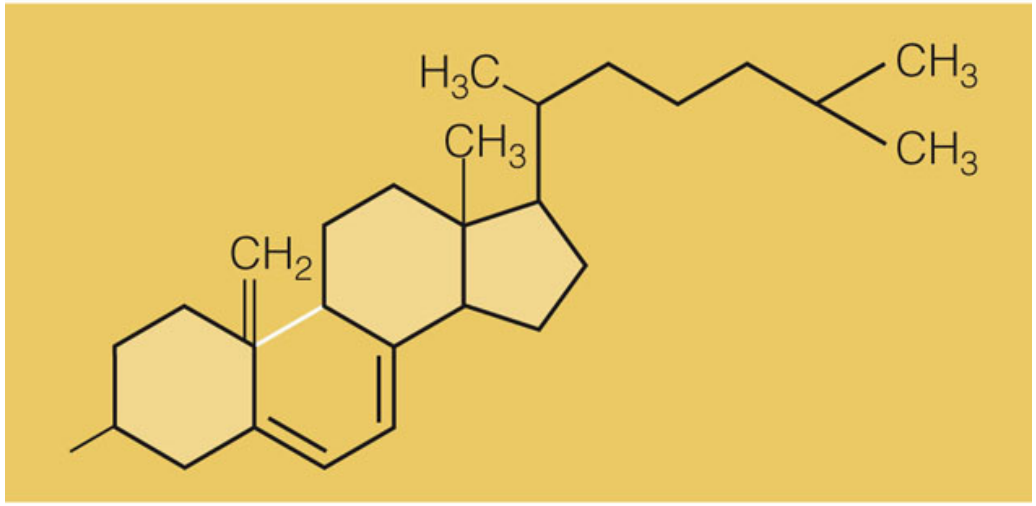
Part HYDROHOBIC, Part HYDROPHILIC (LOVE HATE WITH WATER):

- Phospholipids

Sterols HYDROPHOBIC (HATES WATER):

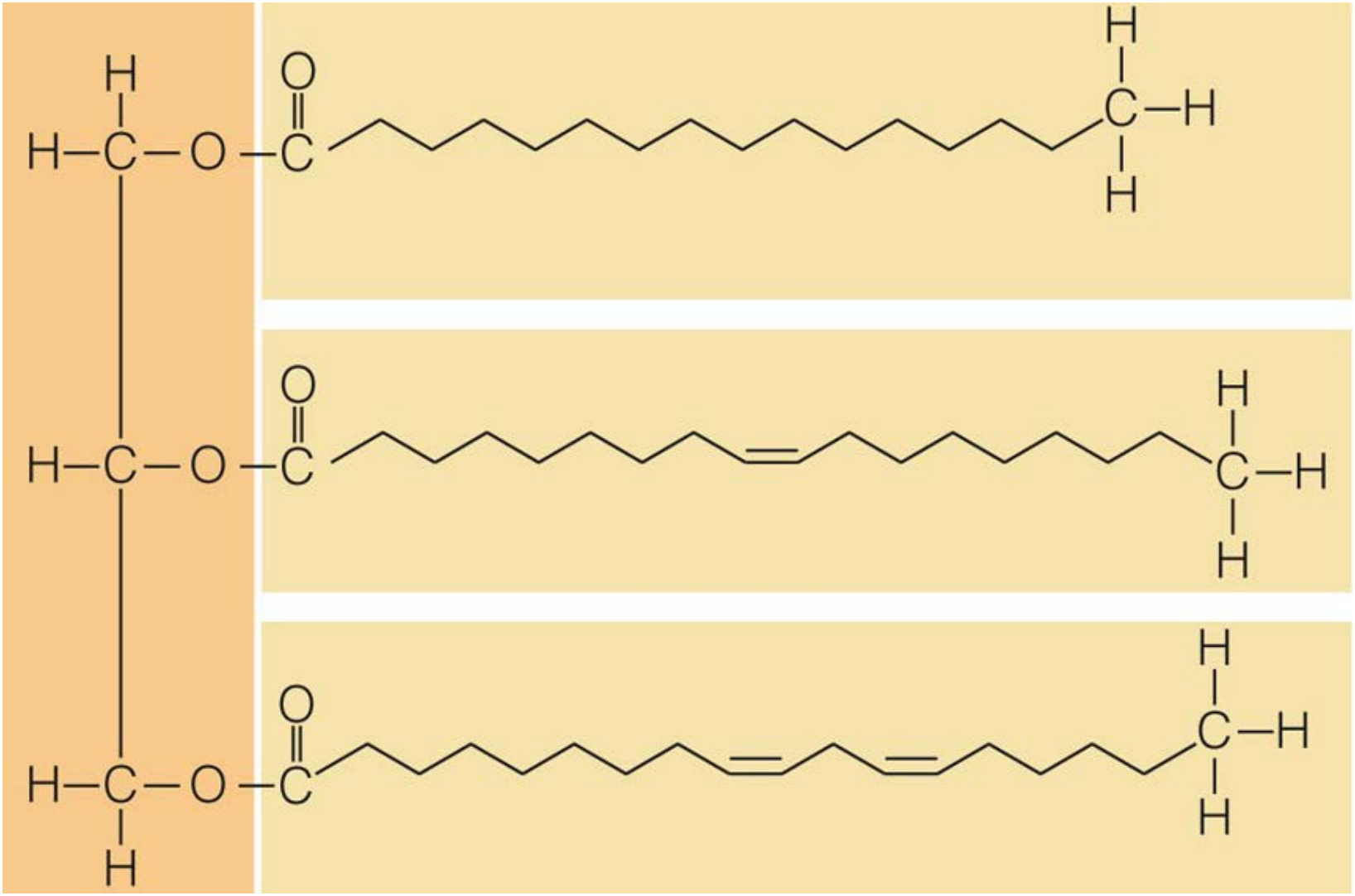


Cholesterol



Vitamin D_3

A generic triglyceride HYDROPHOBIC (HATES WATER):



Phospholipids: (LOVE HATE WITH WATER):

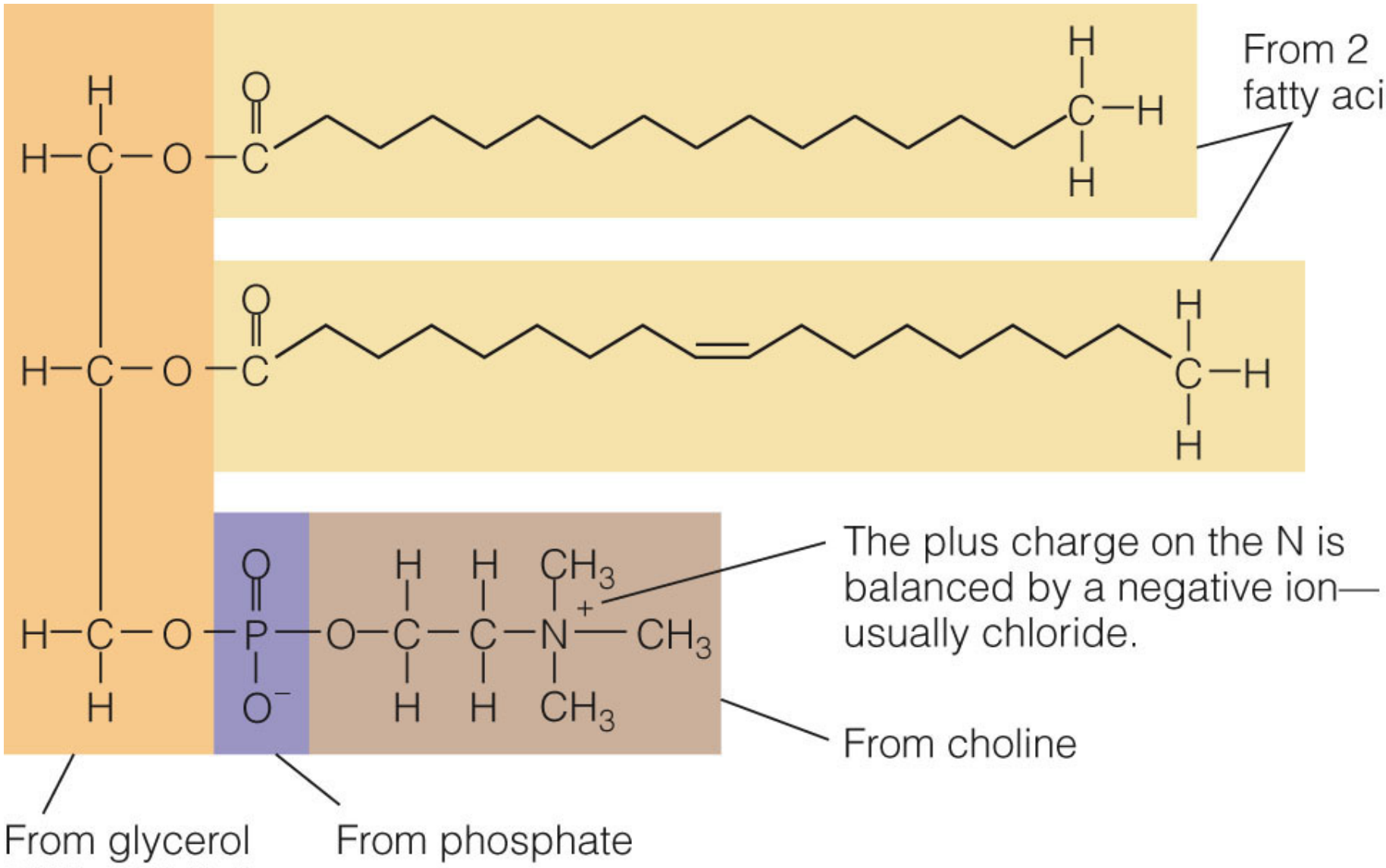
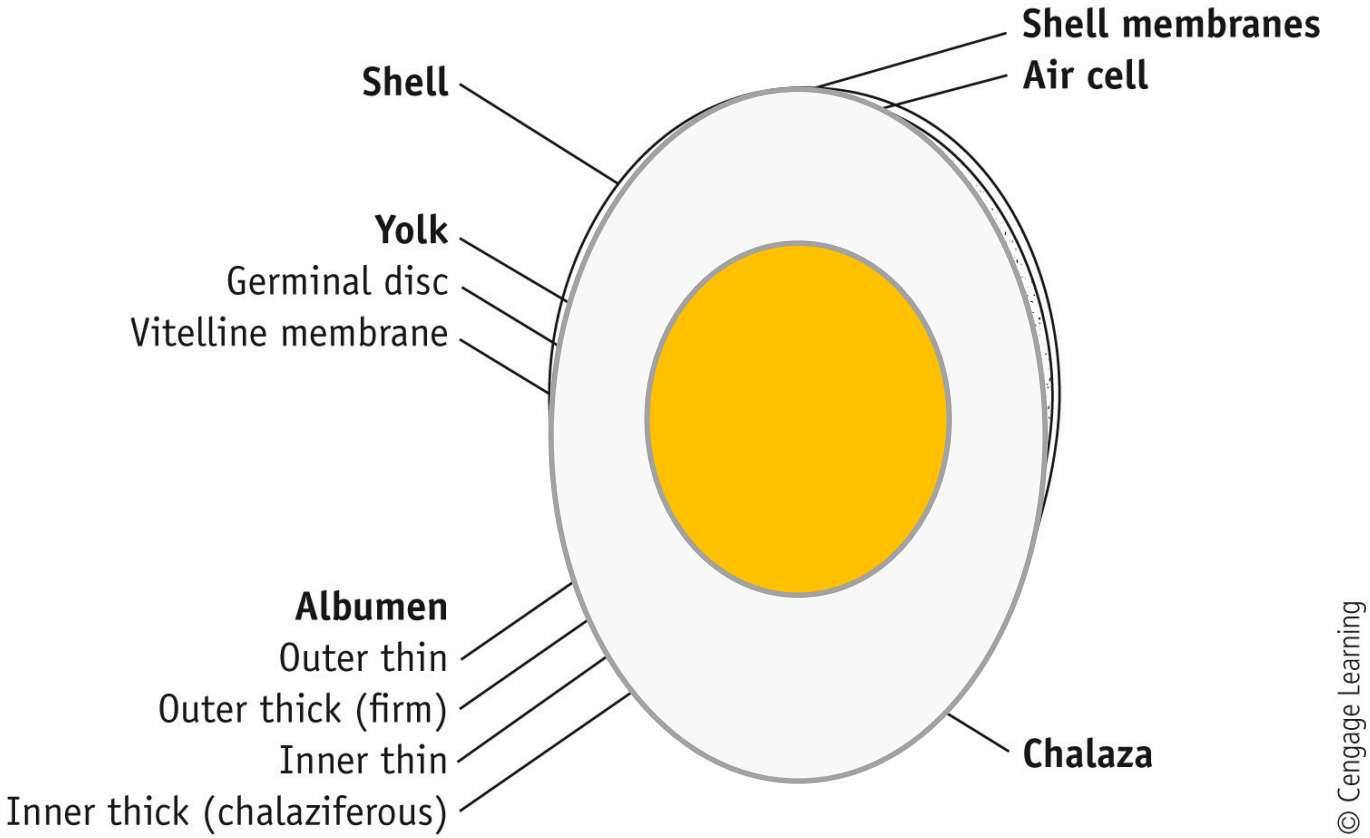
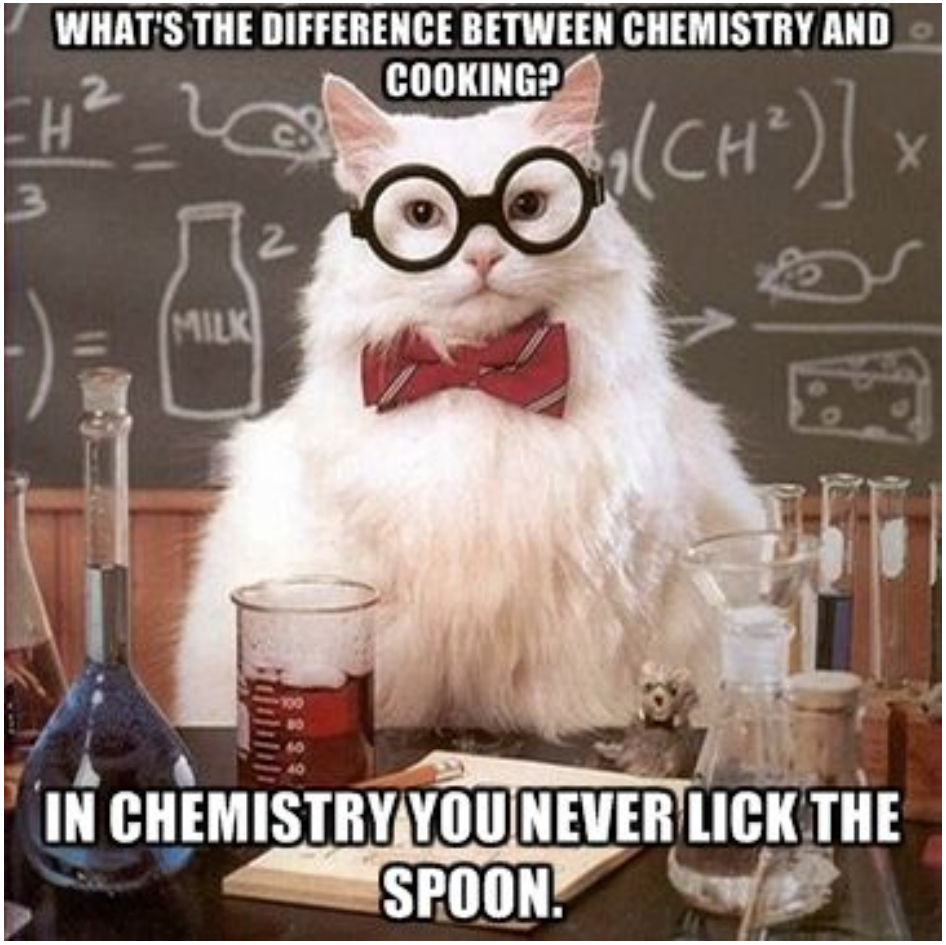


Figure 12-1 p252



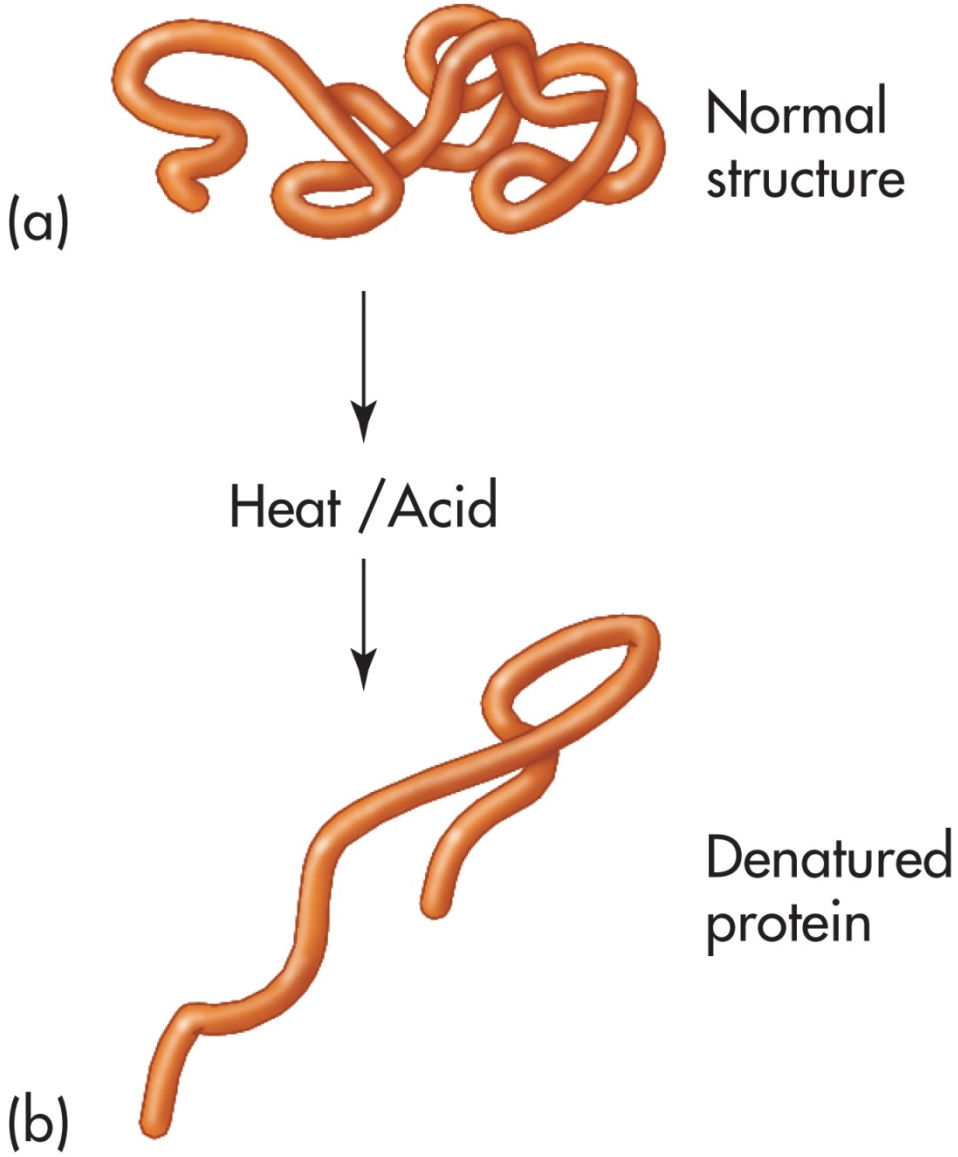
Component	Whole Egg	White	Yolk
Weight	55g	38 g	17 g
Protein	6.6 g	3.9 g	2.7 g
Lipids	6 g	0 g	6 g
Calories	84 kcal	20 g	64 g

What's Cooking?

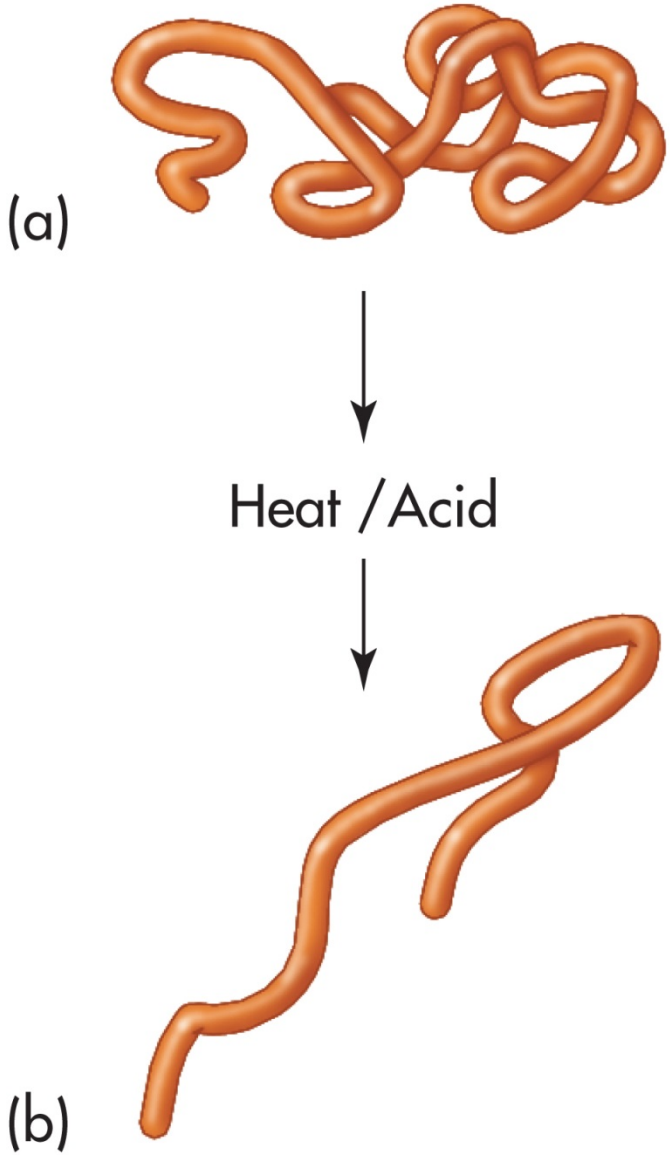


Denaturing proteins: Just apply heat

Denaturation of Proteins



Denaturation of Proteins



“Renaturation” of Proteins

Shear-Stress-Mediated Refolding of Proteins from Aggregates and Inclusion Bodies

CHEMBIOCHEM
Communications

Tom Z. Yuan,[a] Callum F. G. Ormonde,[b] Stephan T. Kudlacek,[c] Sameeran Kunche,[d] Joshua N. Smith,[a] William A. Brown,[c] Kaitlin M. Pugliese,[c] Tivoli J. Olsen,[c] Mariam Iftikhar,[a] Colin L. Raston,*[e] and Gregory A. Weiss*[a, c]

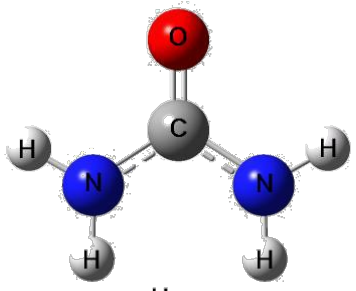
“Renaturation” of Proteins

Shear-Stress-Mediated Refolding of Proteins from Aggregates and Inclusion Bodies

CHEMBIOCHEM
Communications

Tom Z. Yuan,[a] Callum F. G. Ormonde,[b] Stephan T. Kudlacek,[c] Sameeran Kunche,[d] Joshua N. Smith,[a] William A. Brown,[c] Kaitlin M. Pugliese,[c] Tivoli J. Olsen,[c] Mariam Iftikhar,[a] Colin L. Raston,*[e] and Gregory A. Weiss*[a, c]

+



Urea

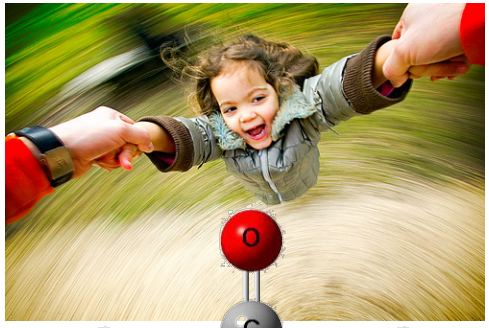
“Renaturation” of Proteins

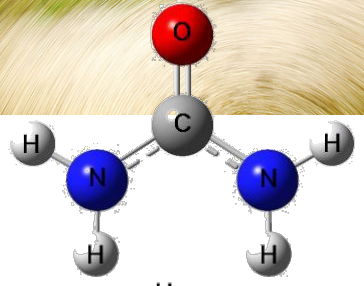
Shear-Stress-Mediated Refolding of Proteins from Aggregates and Inclusion Bodies

CHEMBIOCHEM Communications

Tom Z. Yuan,[a] Callum F. G. Ormonde,[b] Stephan T. Kudlacek,[c] Sameeran Kunche,[d] Joshua N. Smith,[a] William A. Brown,[c] Kaitlin M. Pugliese,[c] Tivoli J. Olsen,[c] Mariam Iftikhar,[a] Colin L. Raston,*[e] and Gregory A. Weiss*[a, c]

+





Urea

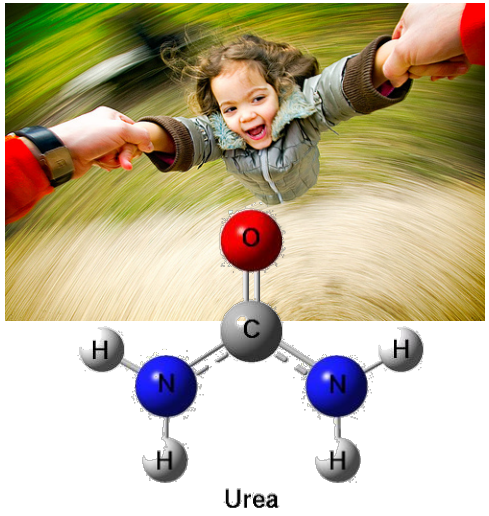
“Renaturation” of Proteins

Shear-Stress-Mediated Refolding of Proteins from Aggregates and Inclusion Bodies

CHEMBIOCHEM Communications

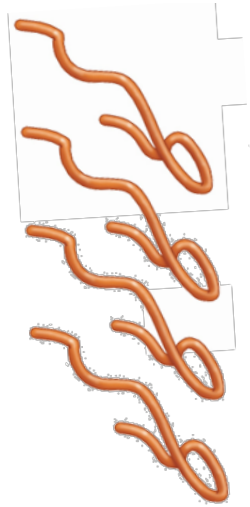
Tom Z. Yuan,[a] Callum F. G. Ormonde,[b] Stephan T. Kudlacek,[c] Sameeran Kunche,[d] Joshua N. Smith,[a] William A. Brown,[c] Kaitlin M. Pugliese,[c] Tivoli J. Olsen,[c] Mariam Iftikhar,[a] Colin L. Raston,*[e] and Gregory A. Weiss*[a, c]

+



Urea

=



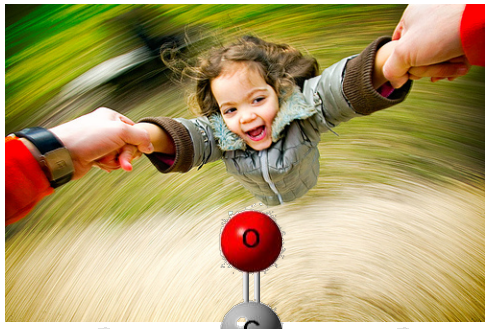
“Renaturation” of Proteins

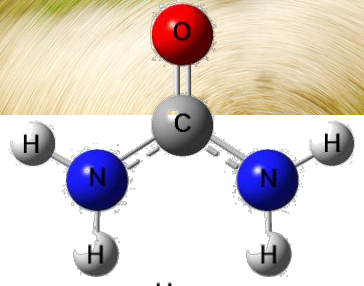
Shear-Stress-Mediated Refolding of Proteins from Aggregates and Inclusion Bodies

CHEMBIOCHEM Communications

Tom Z. Yuan,[a] Callum F. G. Ormonde,[b] Stephan T. Kudlacek,[c] Sameeran Kunche,[d] Joshua N. Smith,[a] William A. Brown,[c] Kaitlin M. Pugliese,[c] Tivoli J. Olsen,[c] Mariam Iftikhar,[a] Colin L. Raston,*[e] and Gregory A. Weiss*[a, c]

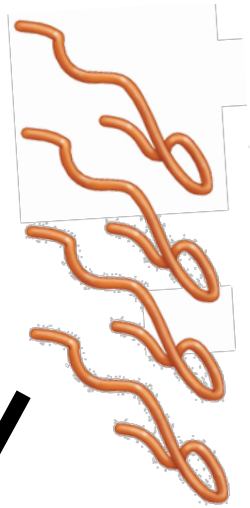
+





Urea

=



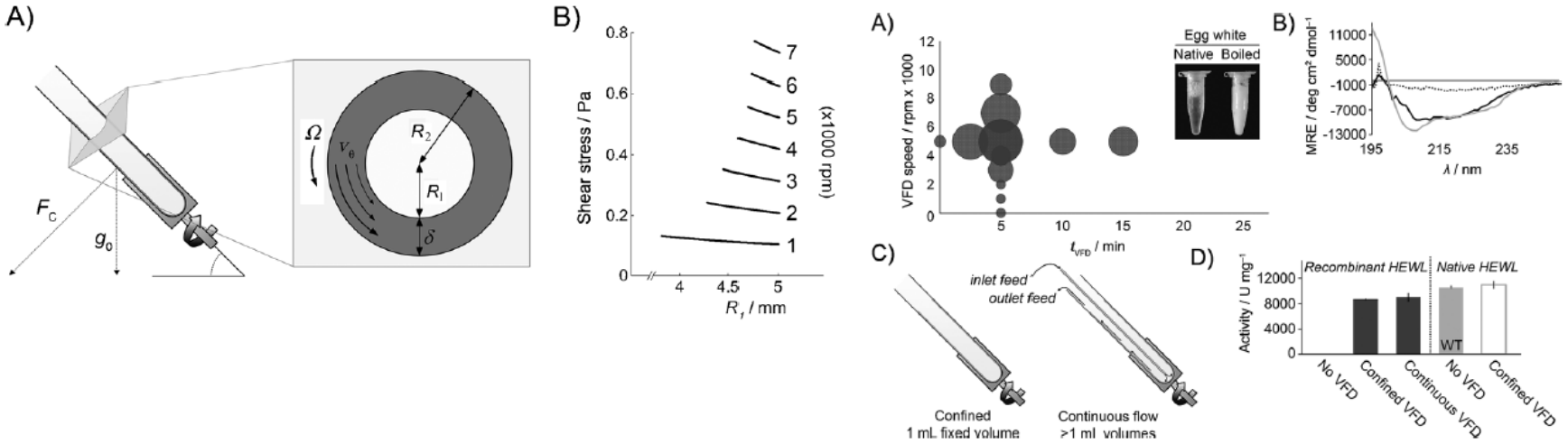
Normal structure

“Renaturation” of Proteins

Shear-Stress-Mediated Refolding of Proteins from Aggregates and Inclusion Bodies

CHEMBIOCHEM Communications

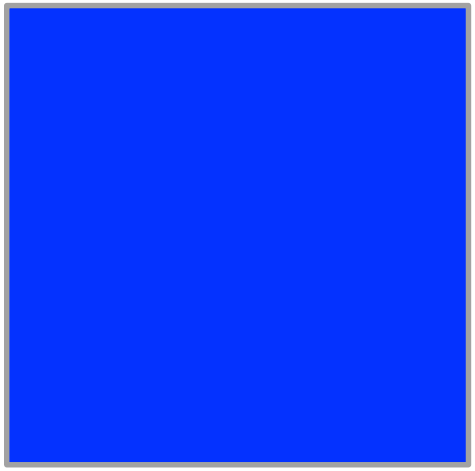
Tom Z. Yuan,[a] Callum F. G. Ormonde,[b] Stephan T. Kudlacek,[c] Sameeran Kunche,[d] Joshua N. Smith,[a] William A. Brown,[c] Kaitlin M. Pugliese,[c] Tivoli J. Olsen,[c] Mariam Iftikhar,[a] Colin L. Raston,*[e] and Gregory A. Weiss*[a, c]



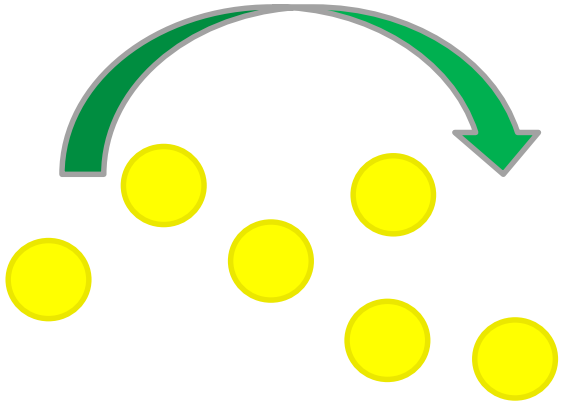
Thickening liquids: It’s all mixed up

How do you make “water” less “watery”?

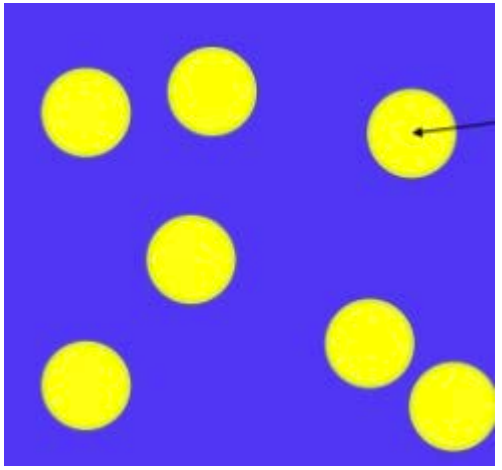
Cram it full of “non-water”!



“Water”

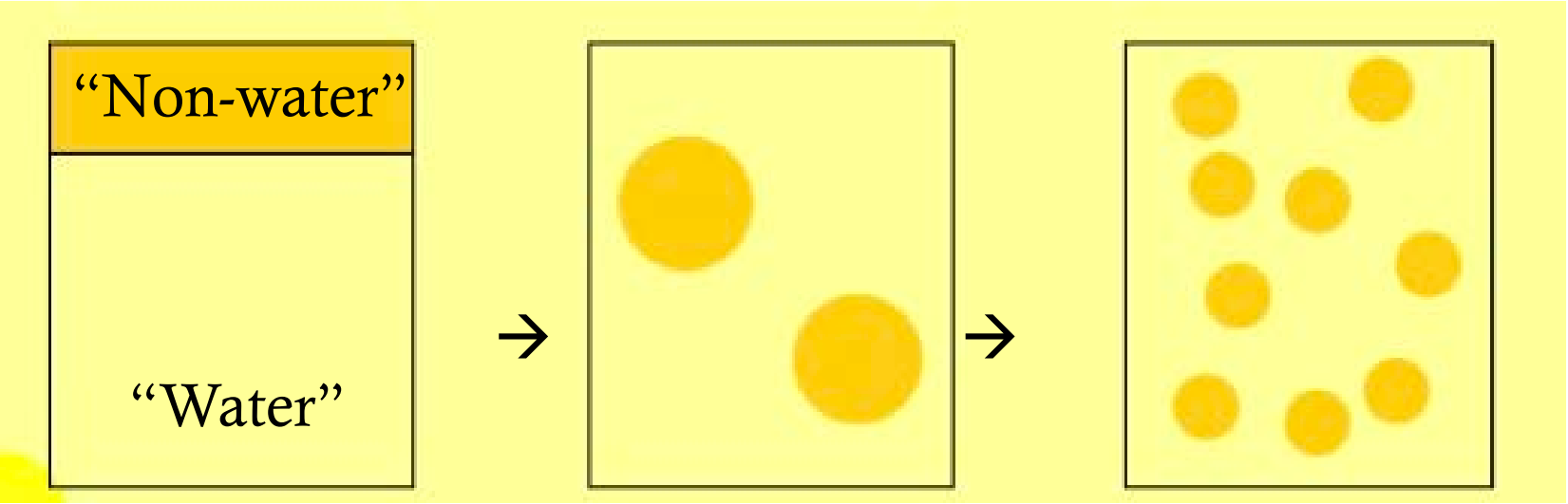


“Non-water”



Dispersion

The more you mix it, the less "watery" it gets

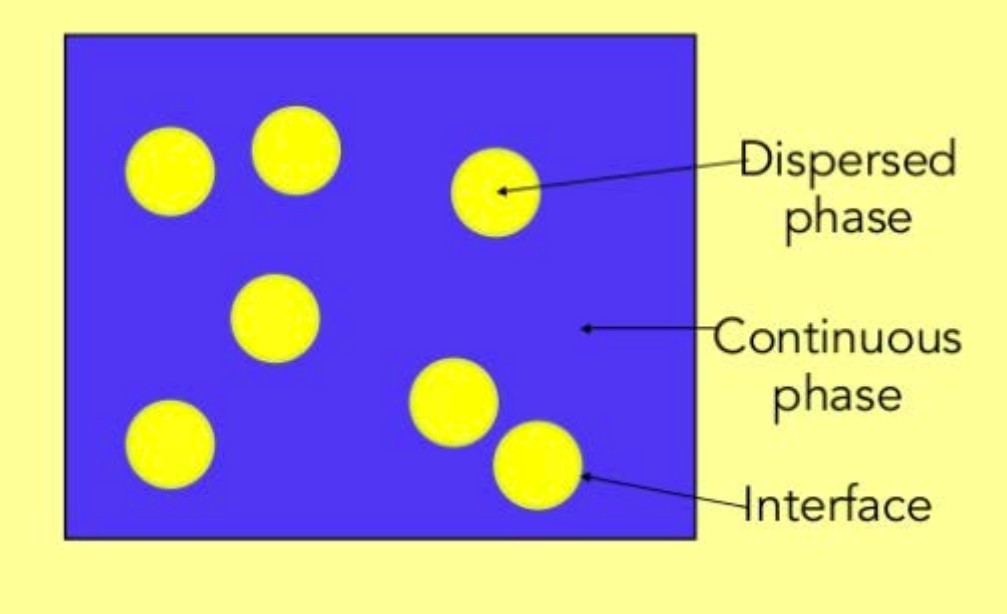


<u>Two things happening here</u>:
Droplet size of "non-water" decreases &
Surface area contact between "water" & "non-water" increases

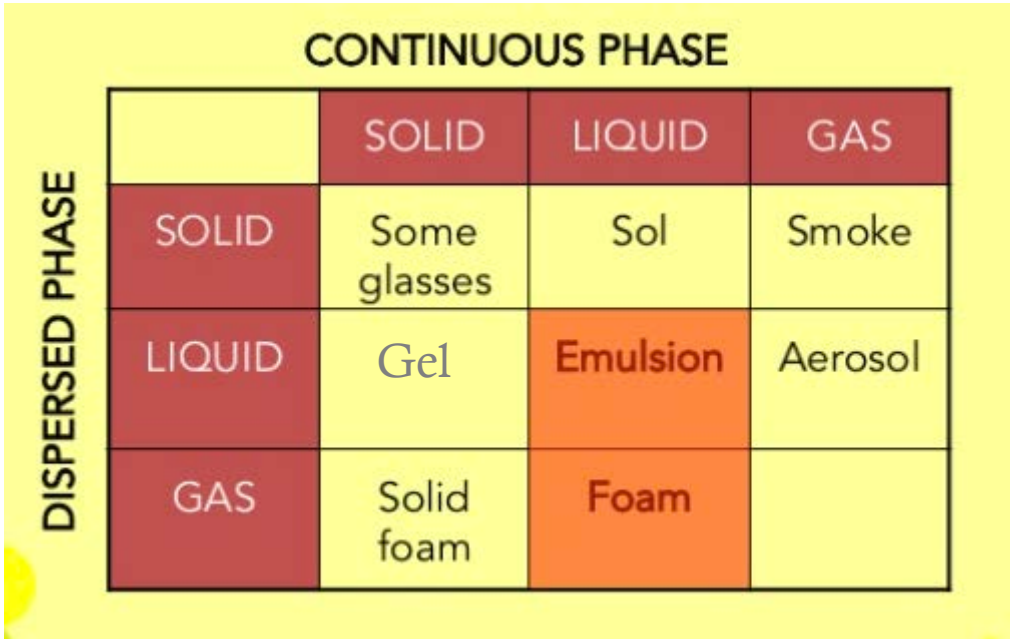
Types of “non-water”:

- Air bubbles
- Oil droplets
- Plant or animal particles

The technical terms



Types of Dispersions



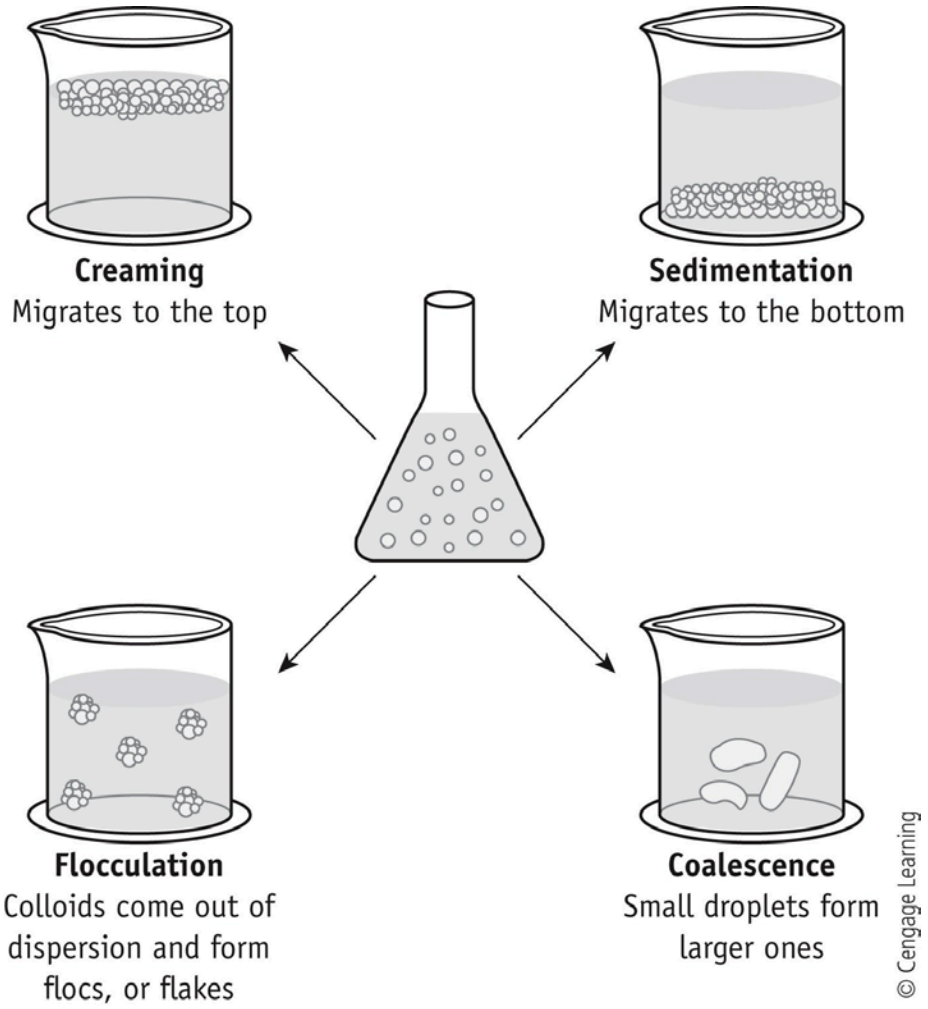
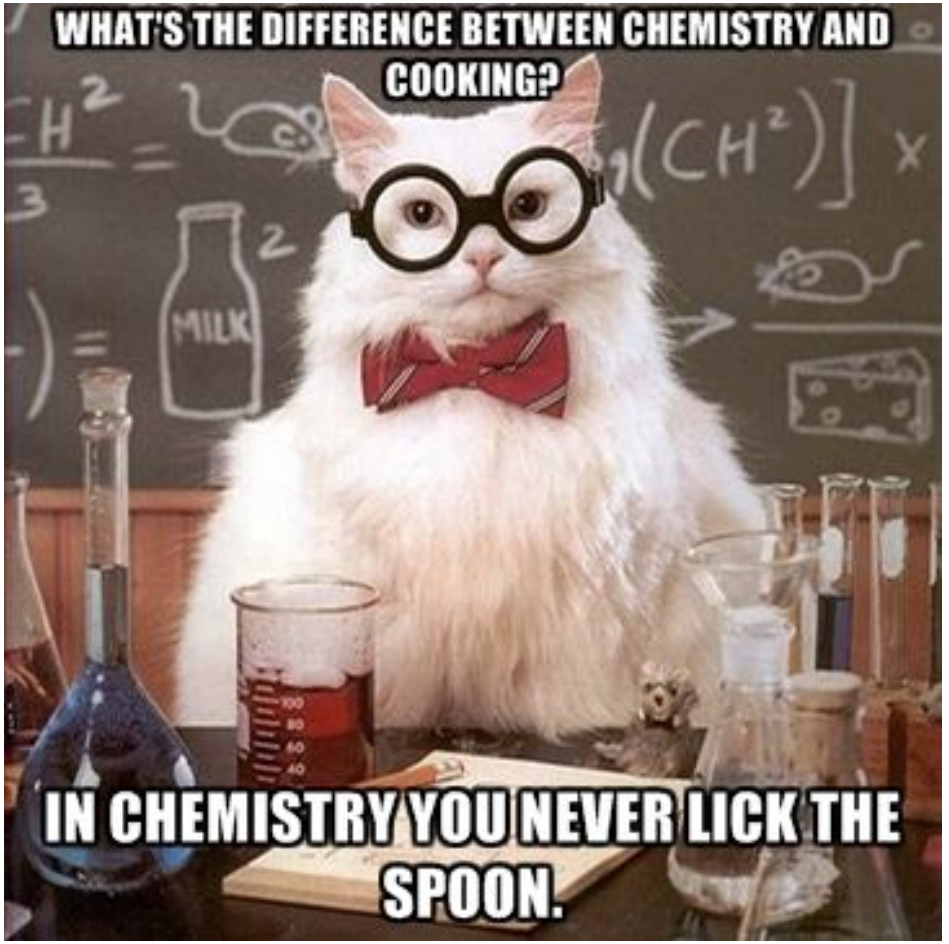


Figure 3-7 p38

What's Cooking?



Thickening by Adding Air:

FOAMS

(a) Foamy

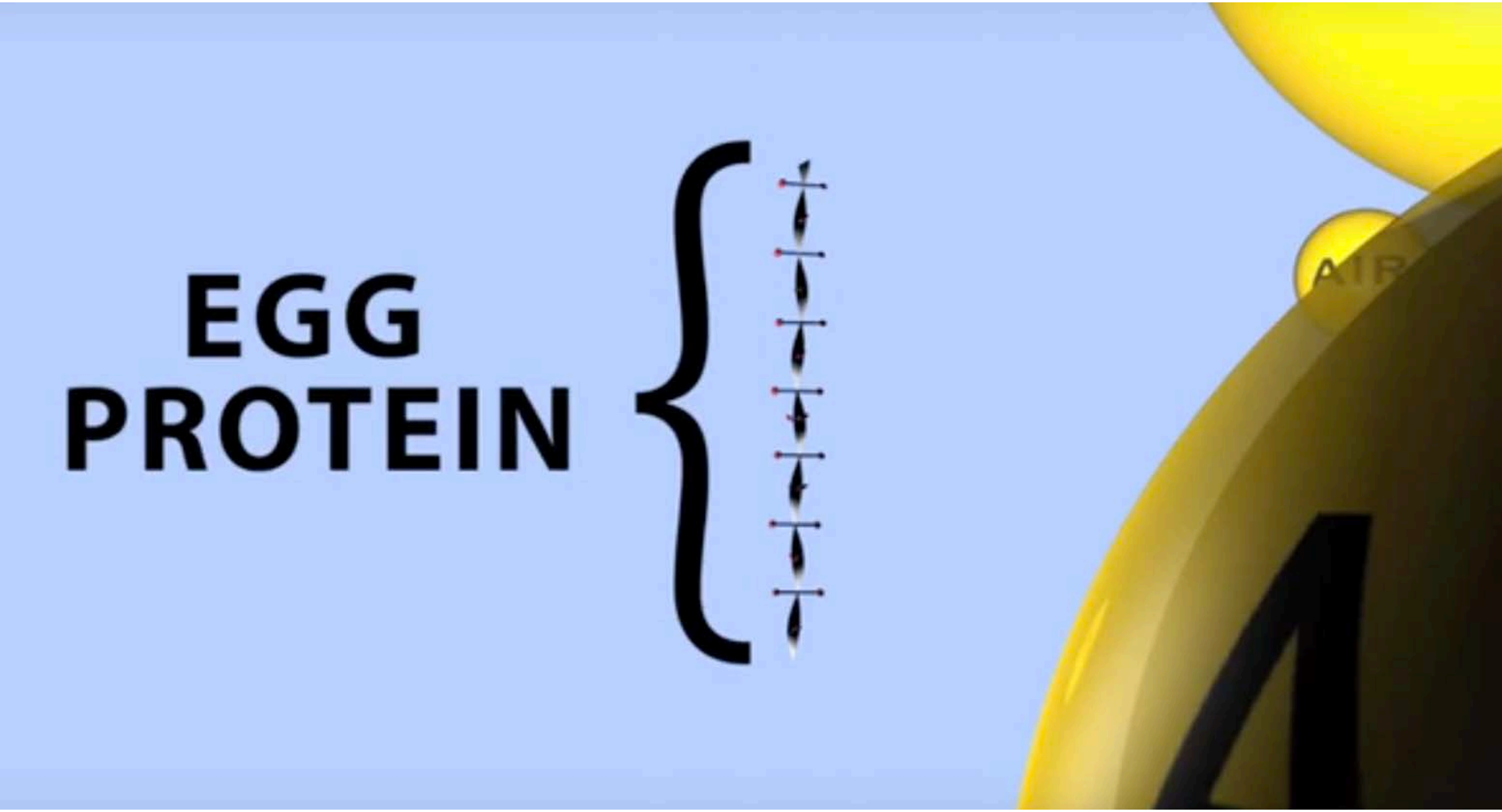
(b) Soft peaks

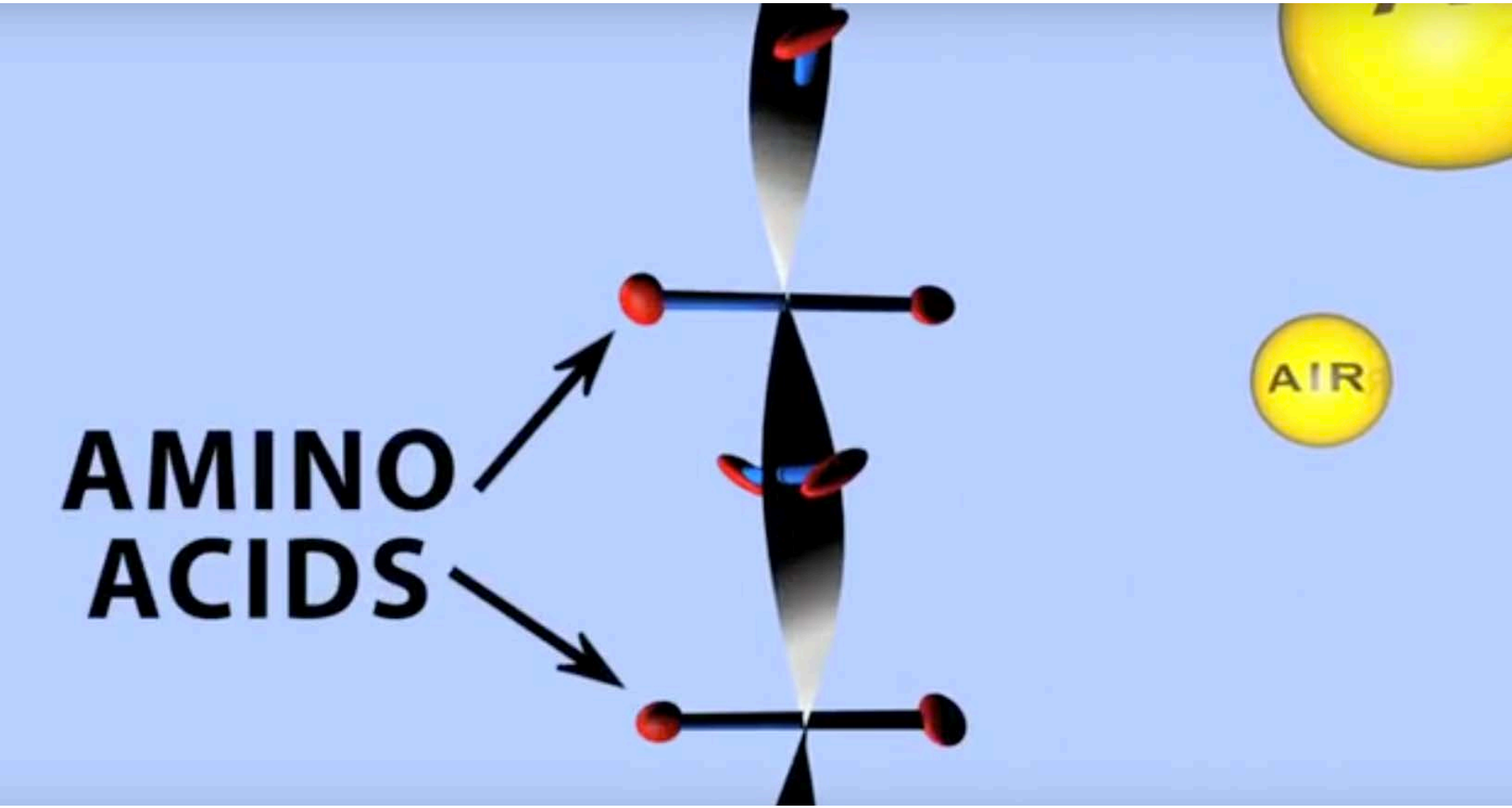
(c) Stiff peaks

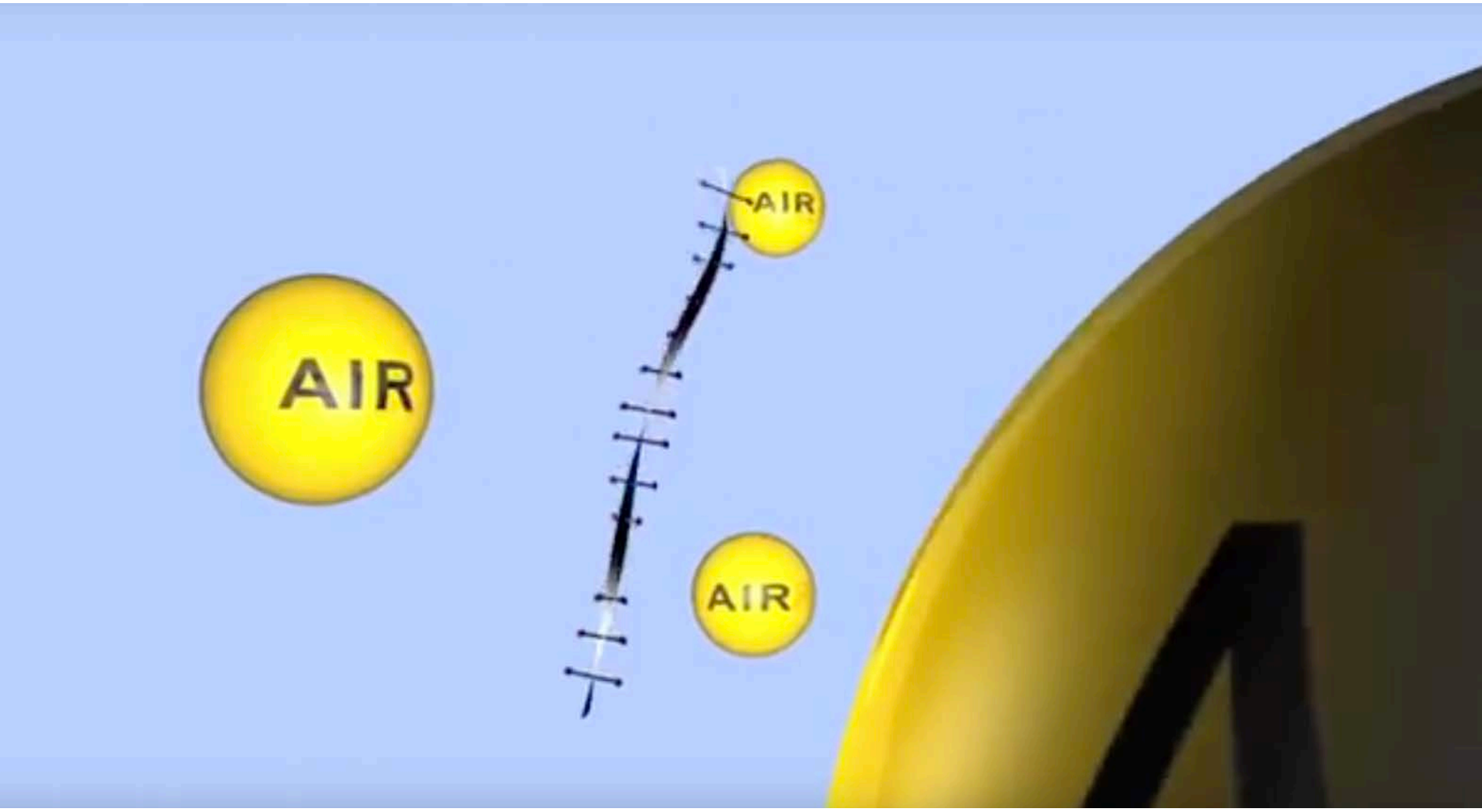
(d) Dry peaks

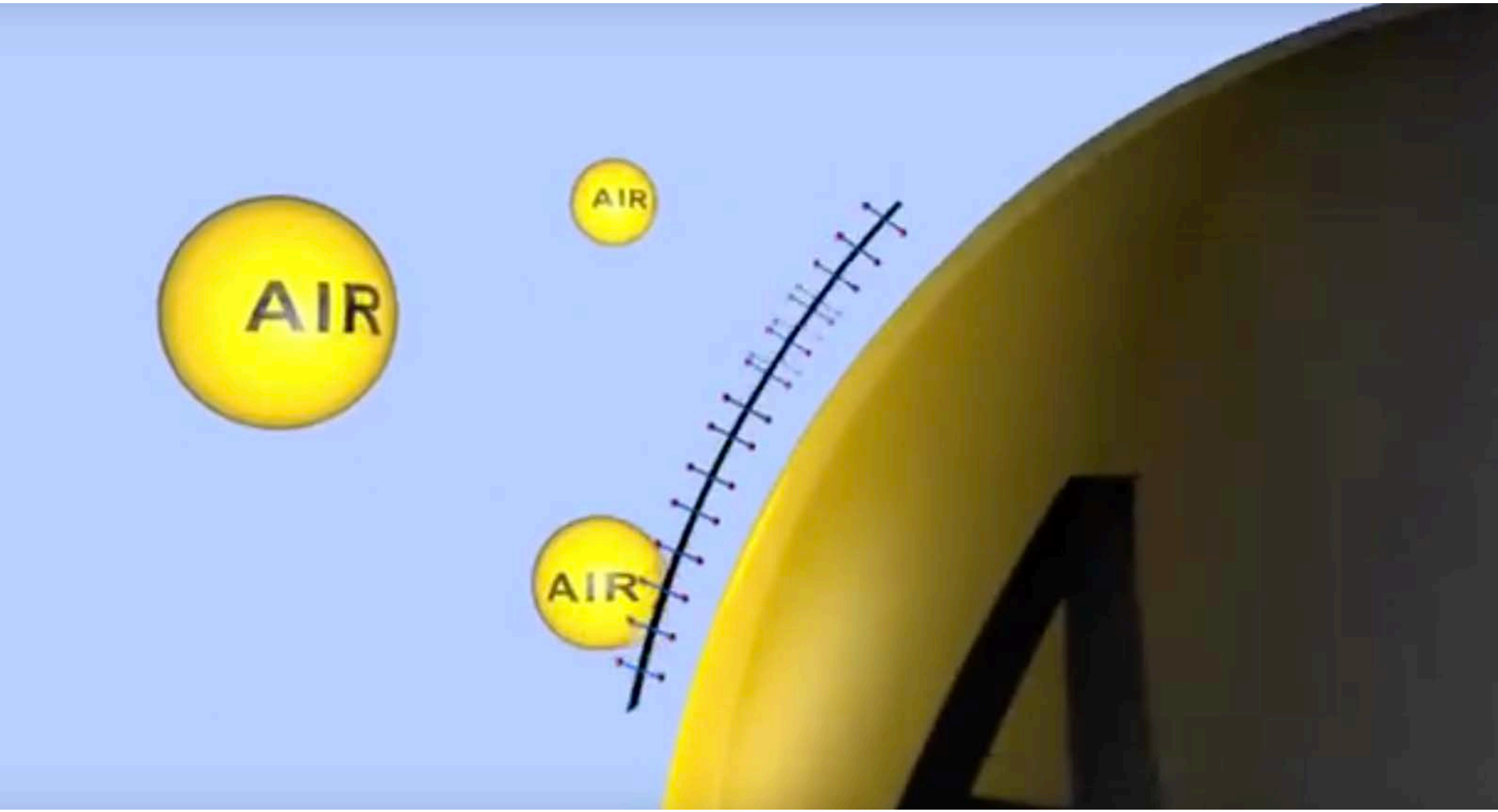
Digital Works

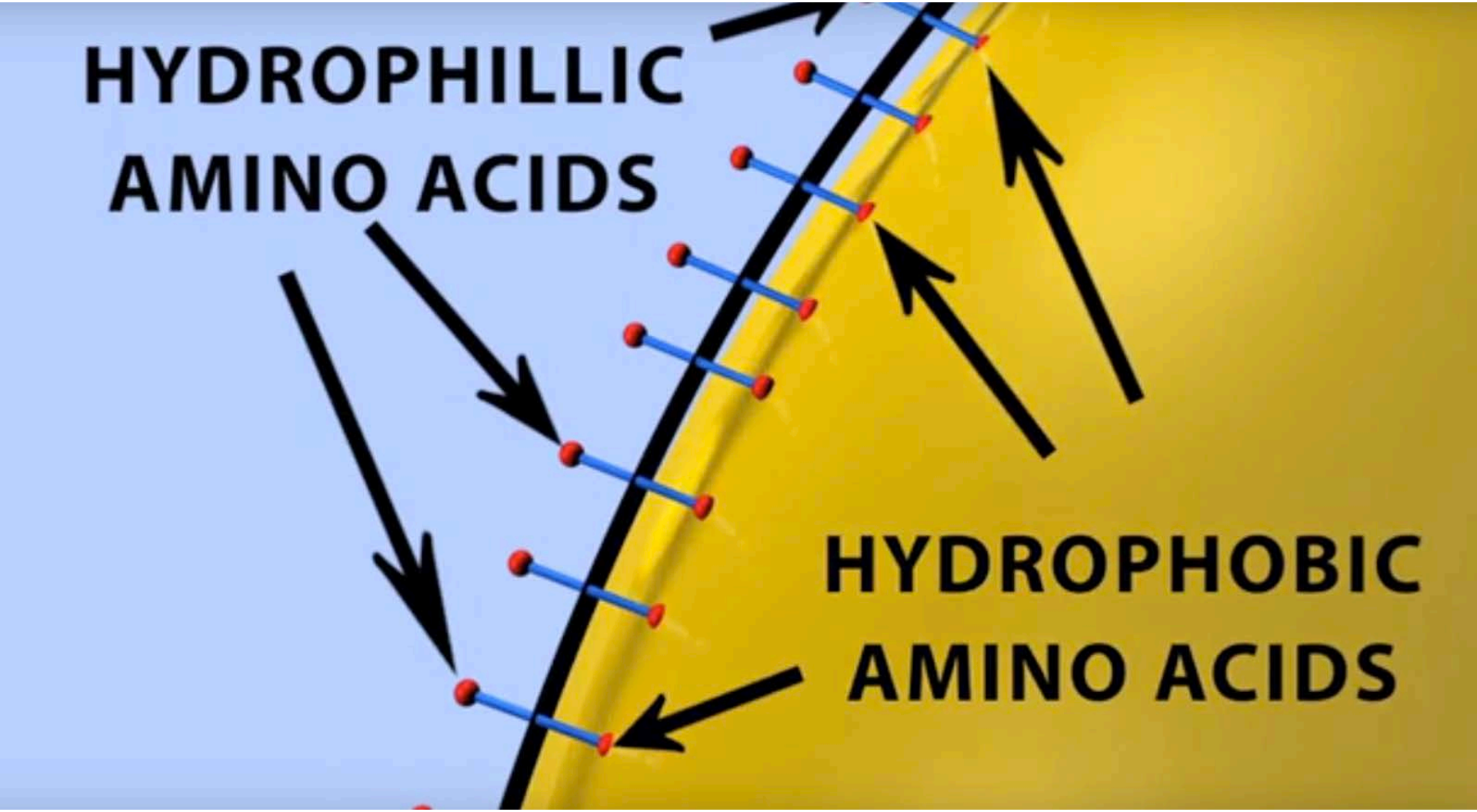
Figure 12-8 p258


EGG
PROTEIN

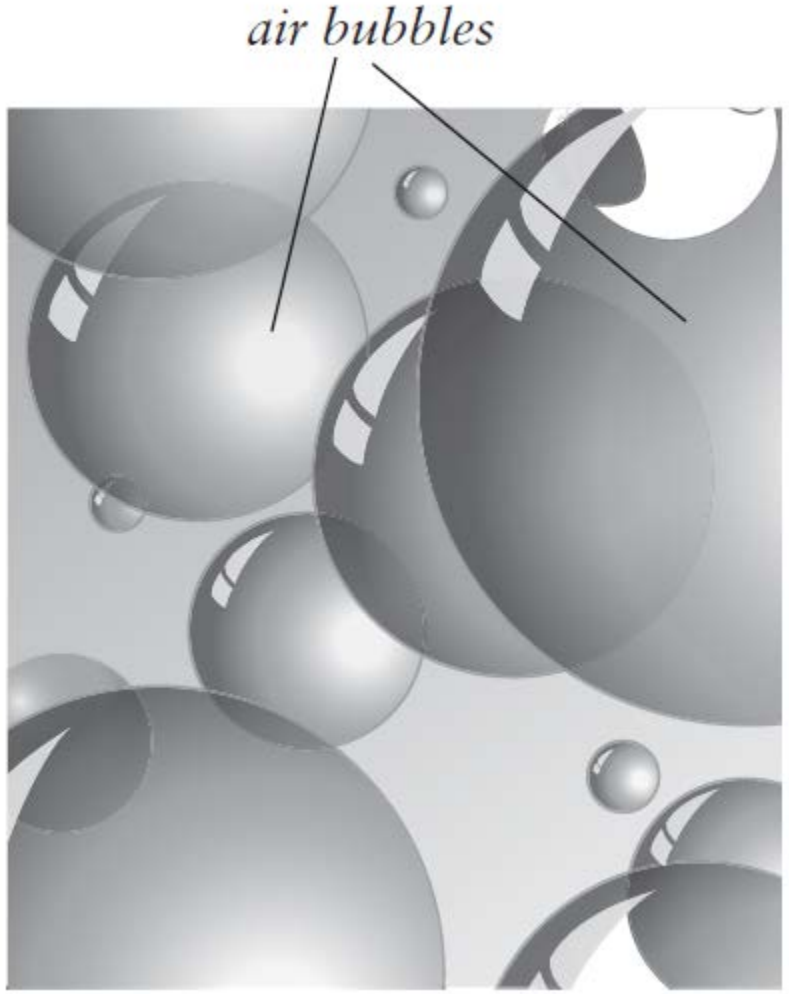

AMINO
ACIDS
AIR


AIR
AIR
AIR

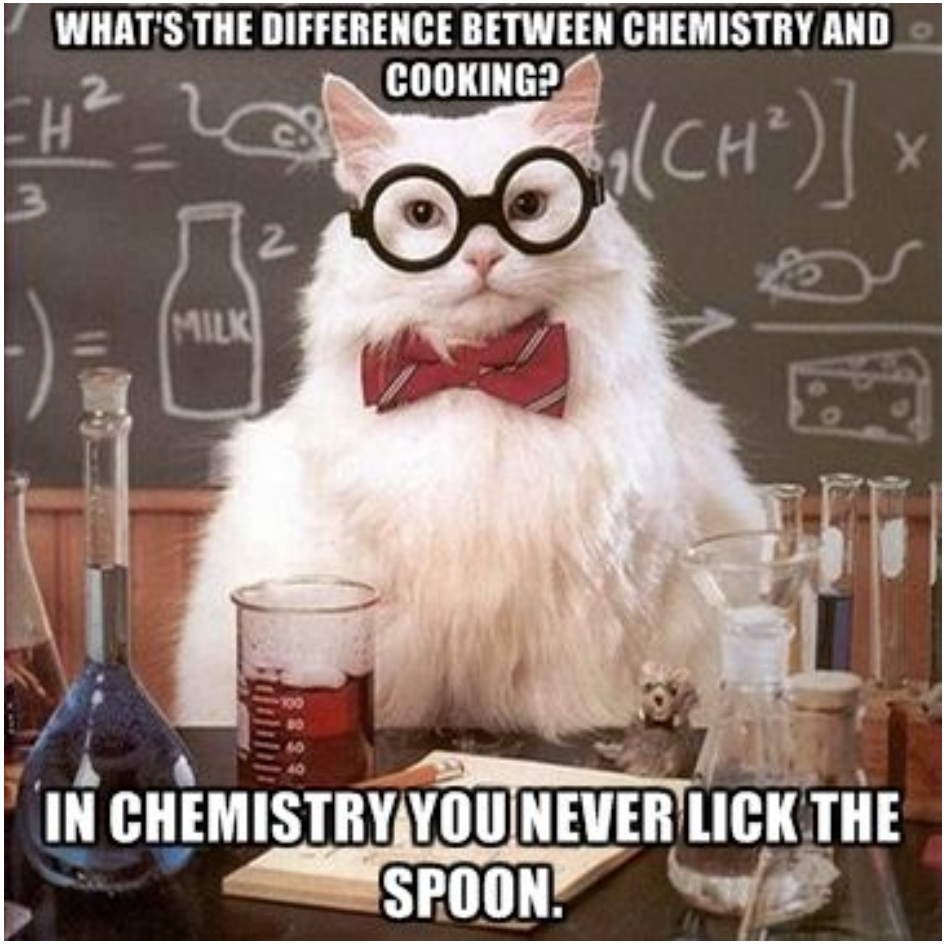

AIR
AIR
AIR


HYDROPHILLIC
AMINO ACIDS
HYDROPHOBIC
AMINO ACIDS

Thickening with air:



What's Cooking?



Thickening by Combining Oil and Water: EMULSIONS

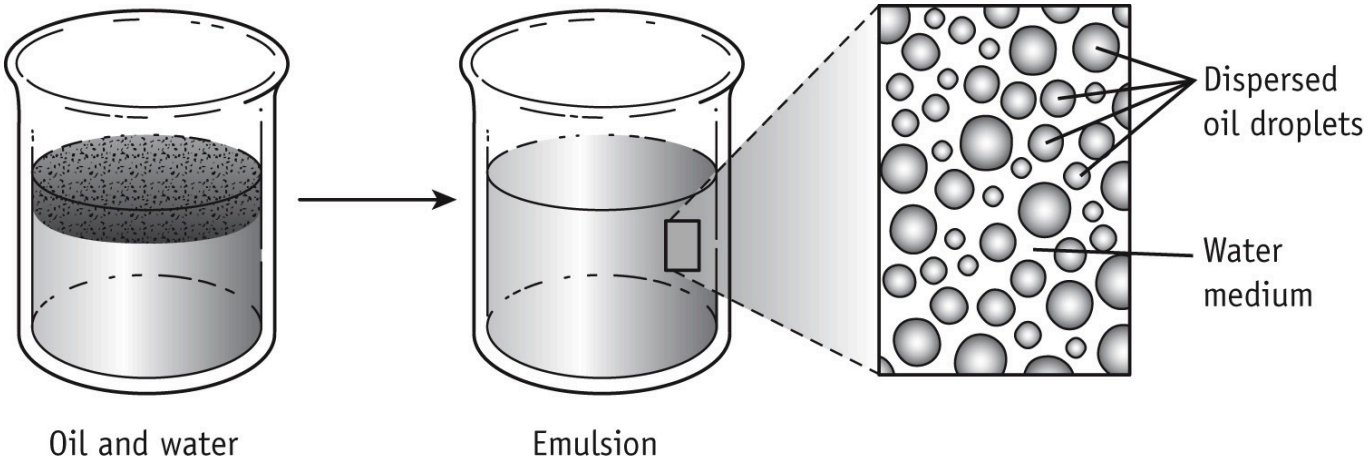
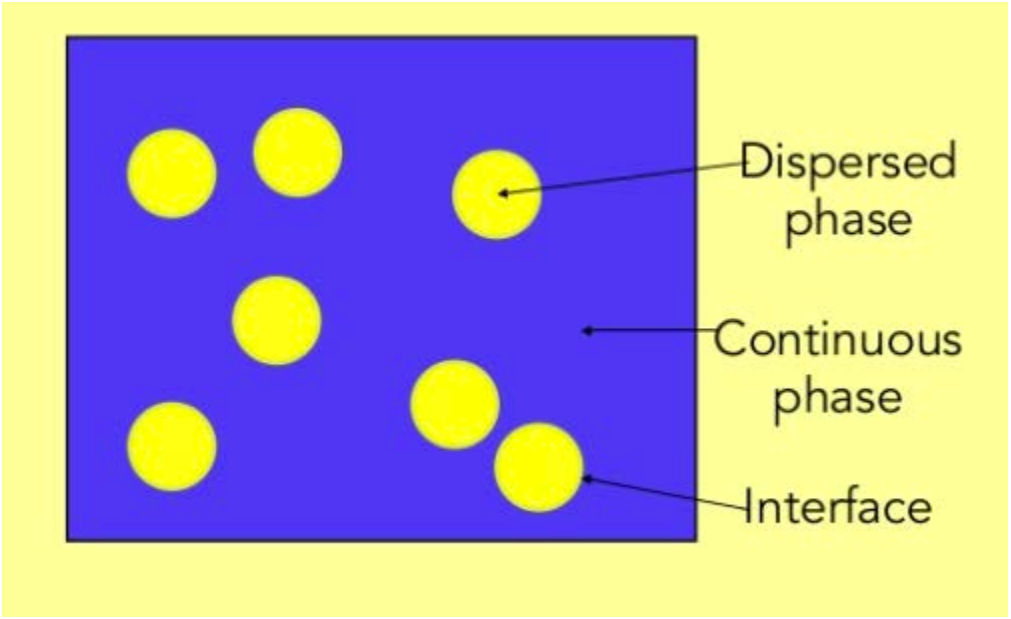


Figure 22-2 p455

Revisiting the technical terms



= Oil

= Water

= Emulsifier
(Phospholipid from Egg)

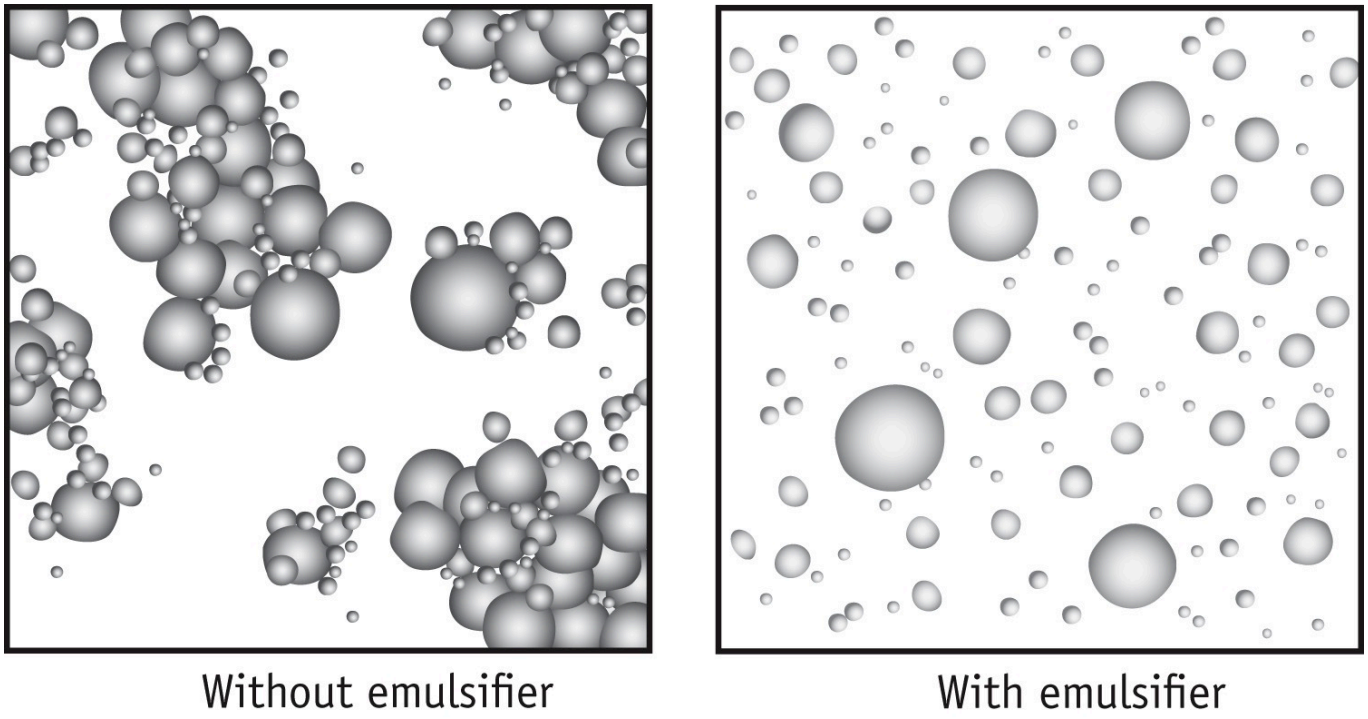
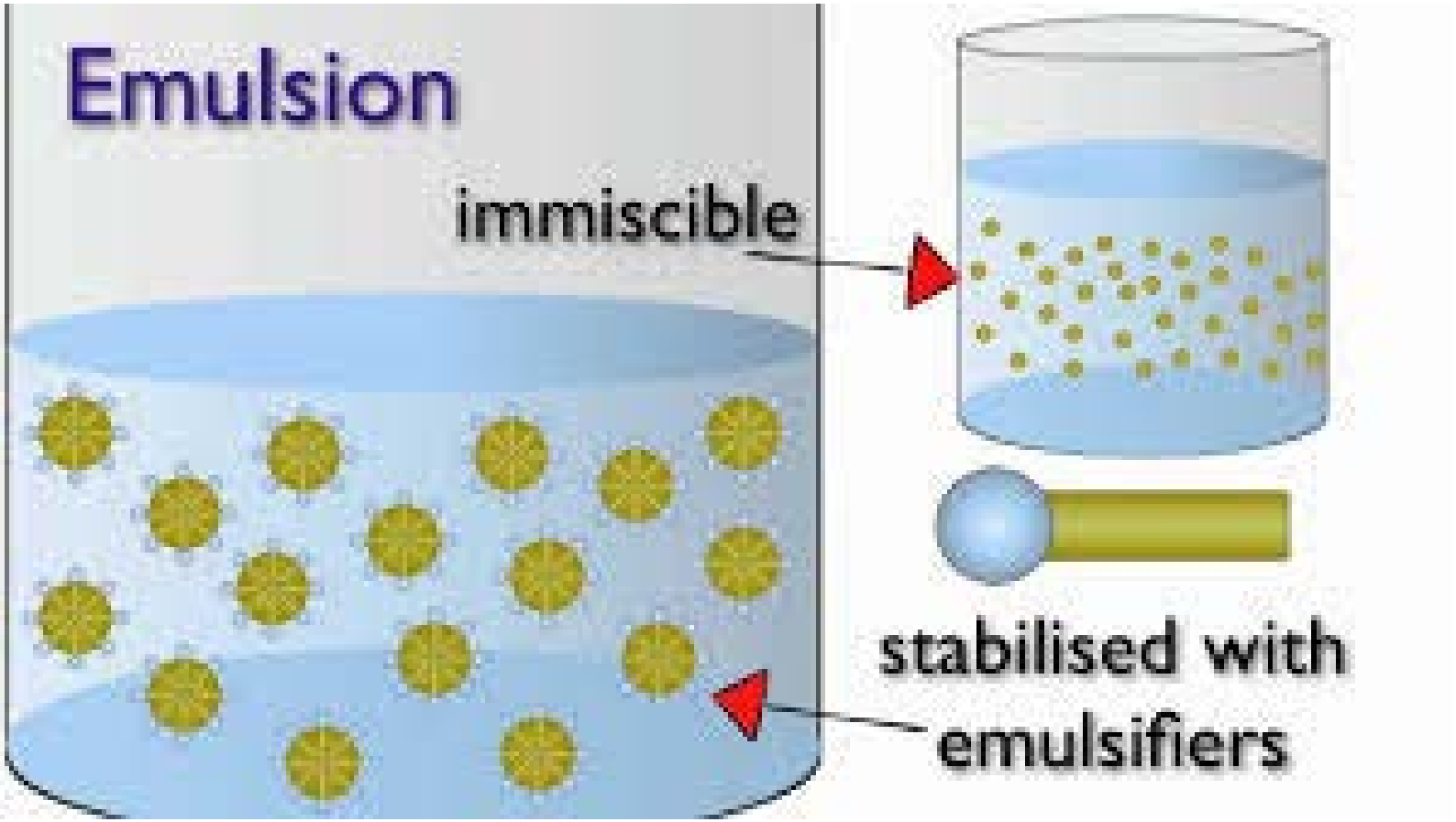
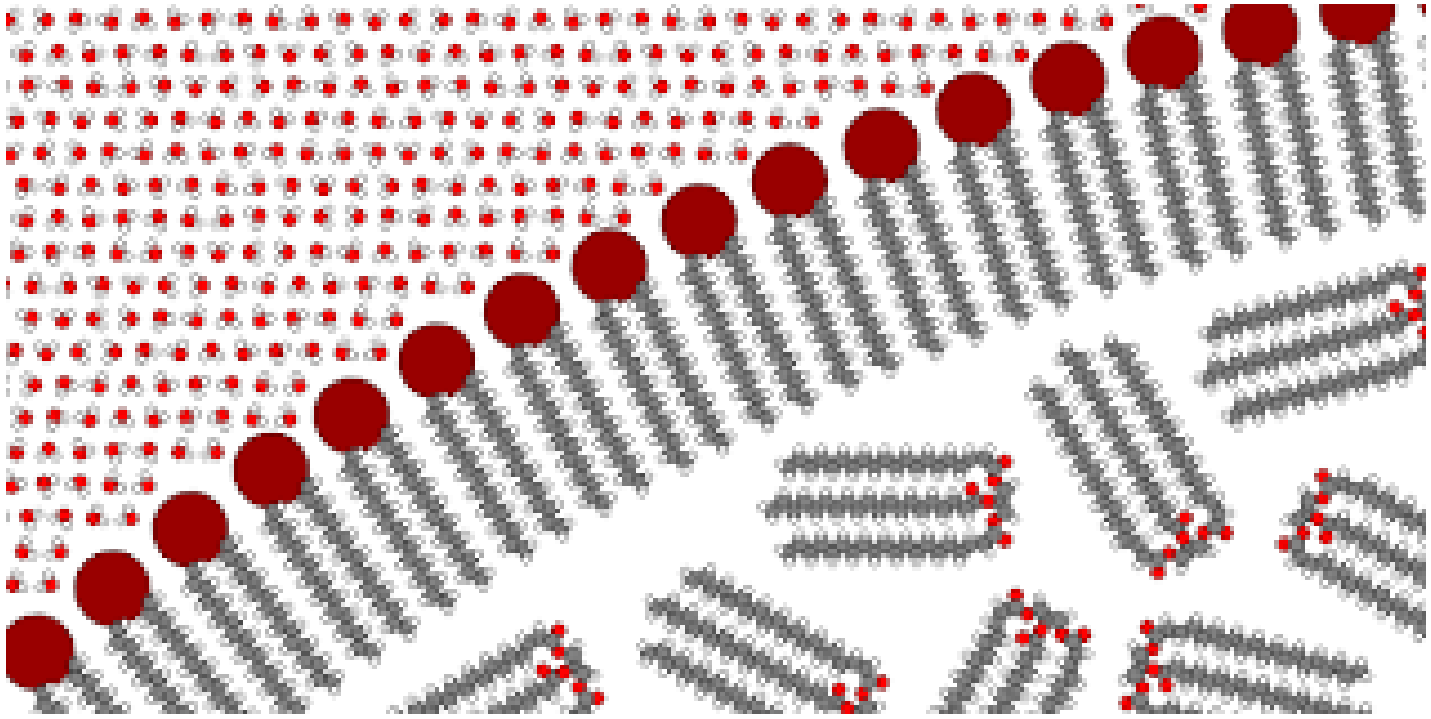


Figure 22-4 p456

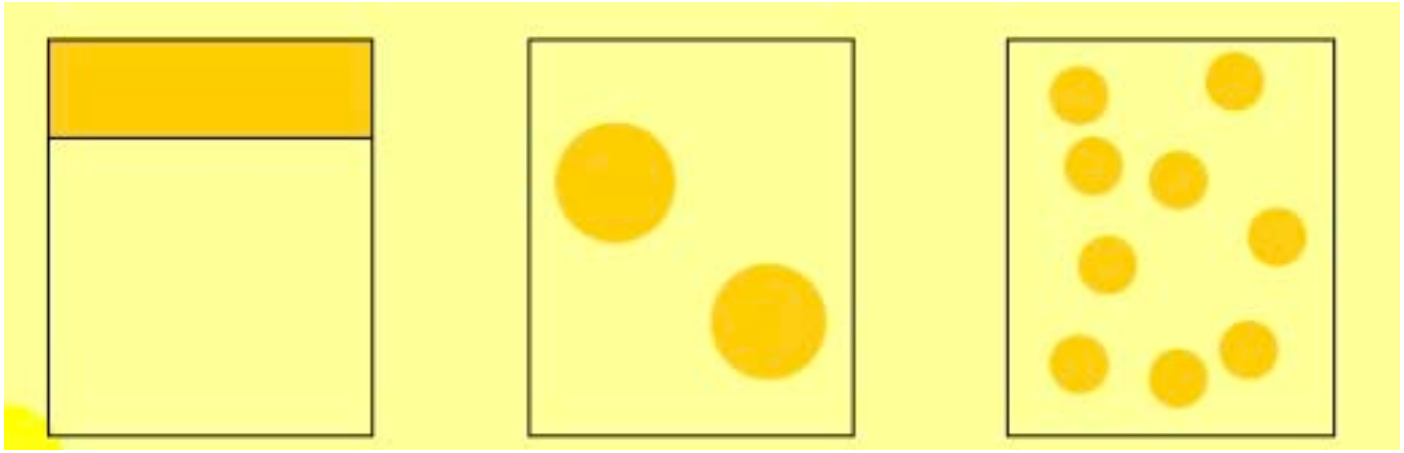

Emulsion
immiscible
stabilised with
emulsifiers

Water & Hydrophilic Heads



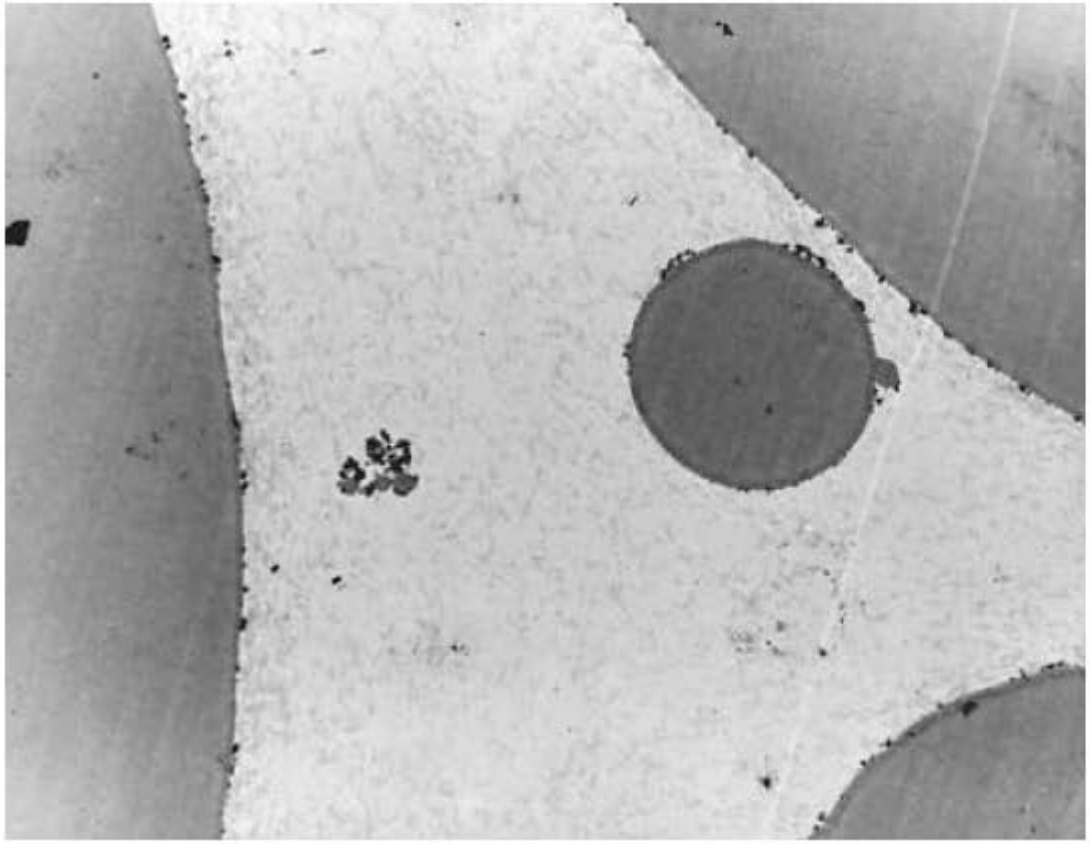
Lipids & Hydrophobic Tails

Emulsifiers help increase surface area contact



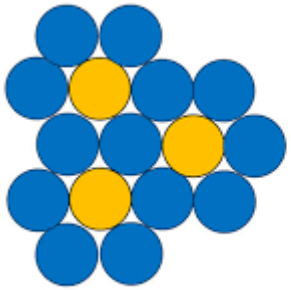
One category of emulsifiers are SURFACTANTS = Surface Active Agents

Mayonnaise: Electron Microscope View

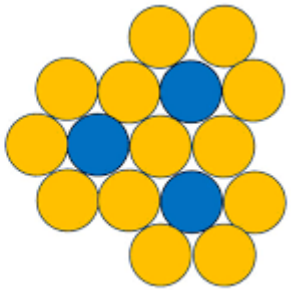


Oil droplets in mayonnaise. A view through an electron microscope. Protein and emulsifier molecules and aggregates, all from egg yolk, are present between the large droplets and on their surfaces, and help prevent them from coalescing.

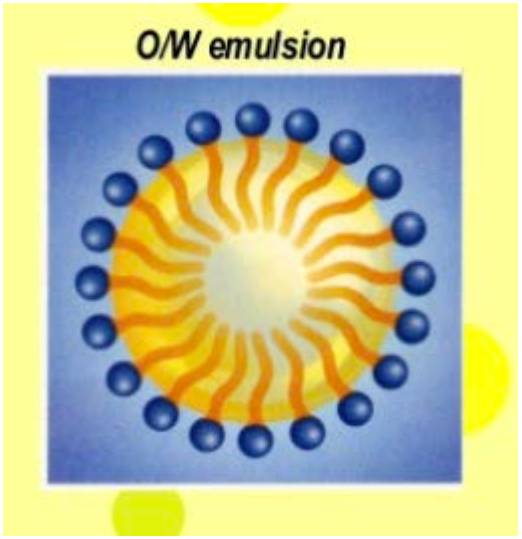
It works both ways

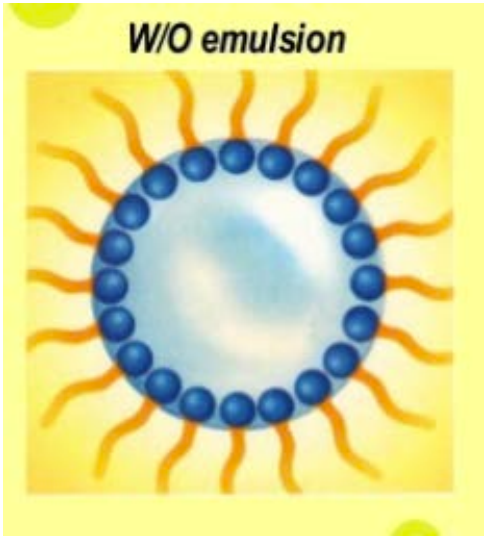


Oil-in-Water Emulsion

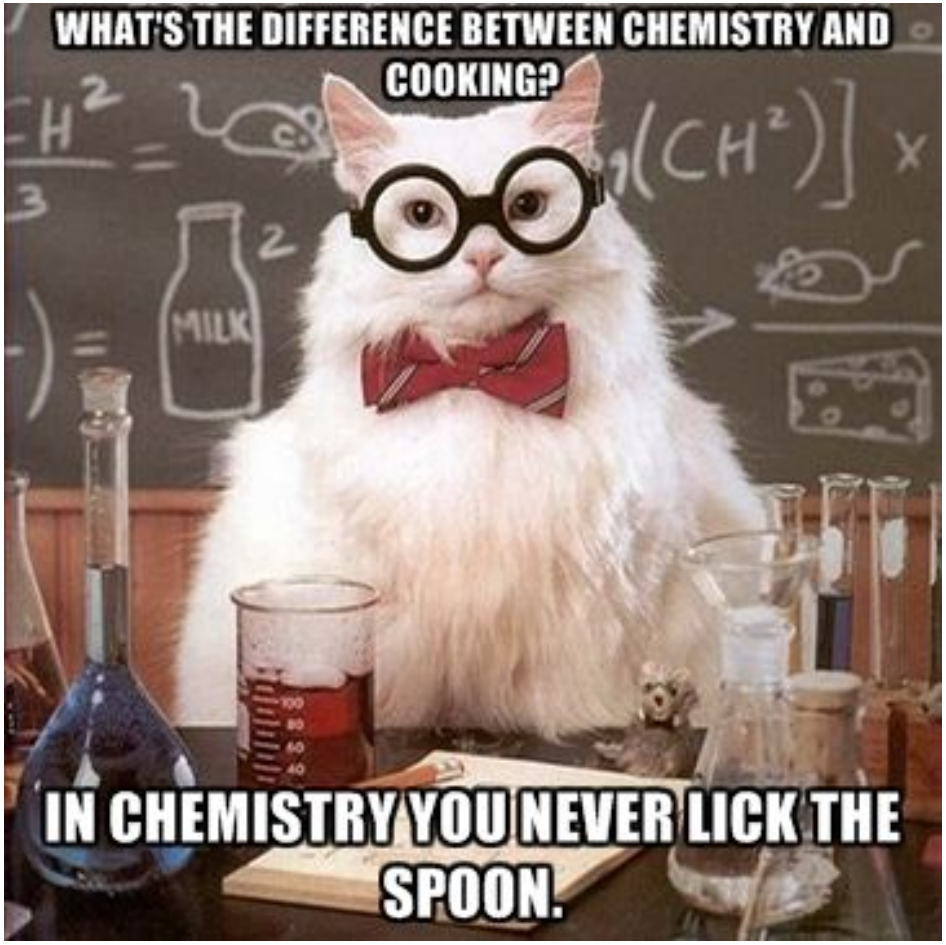


Water-in-Oil Emulsion

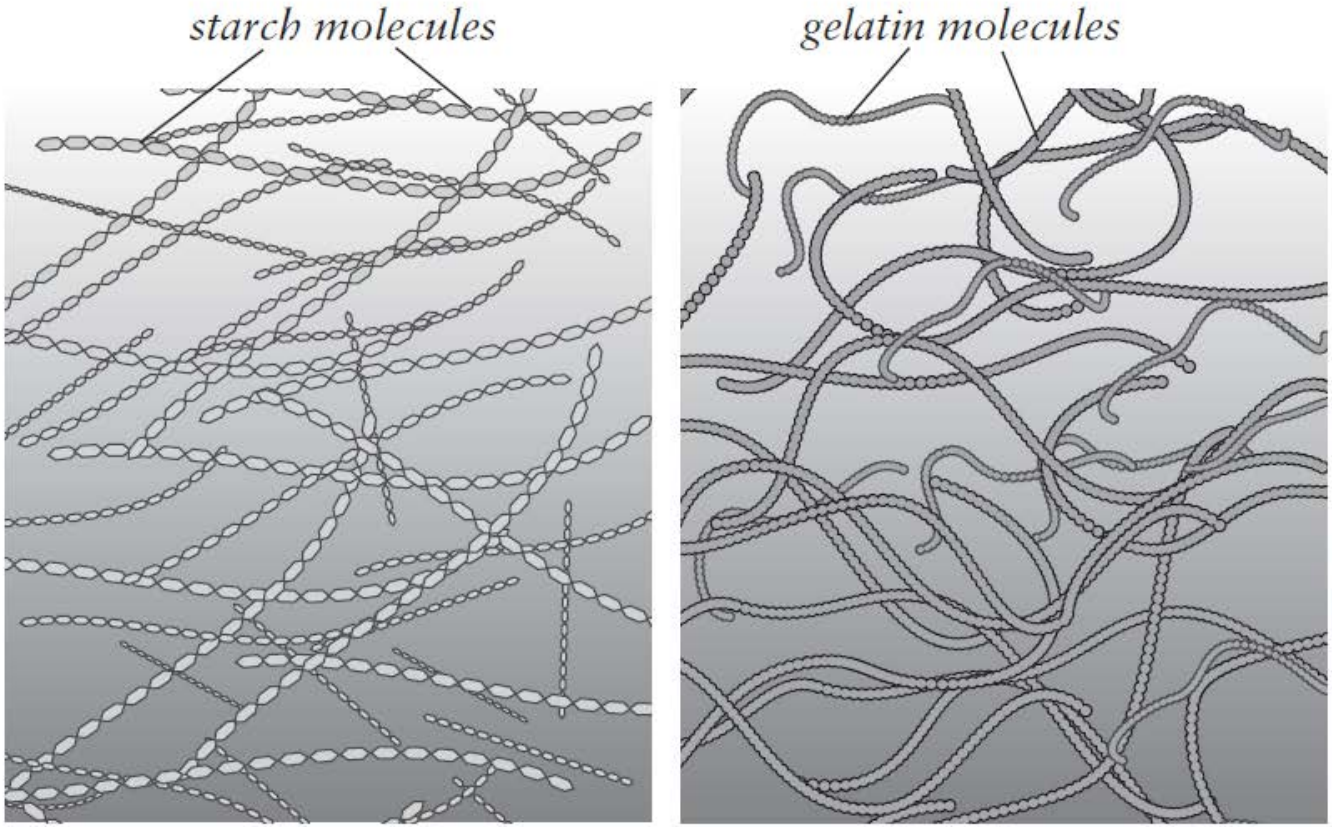




What's Cooking?

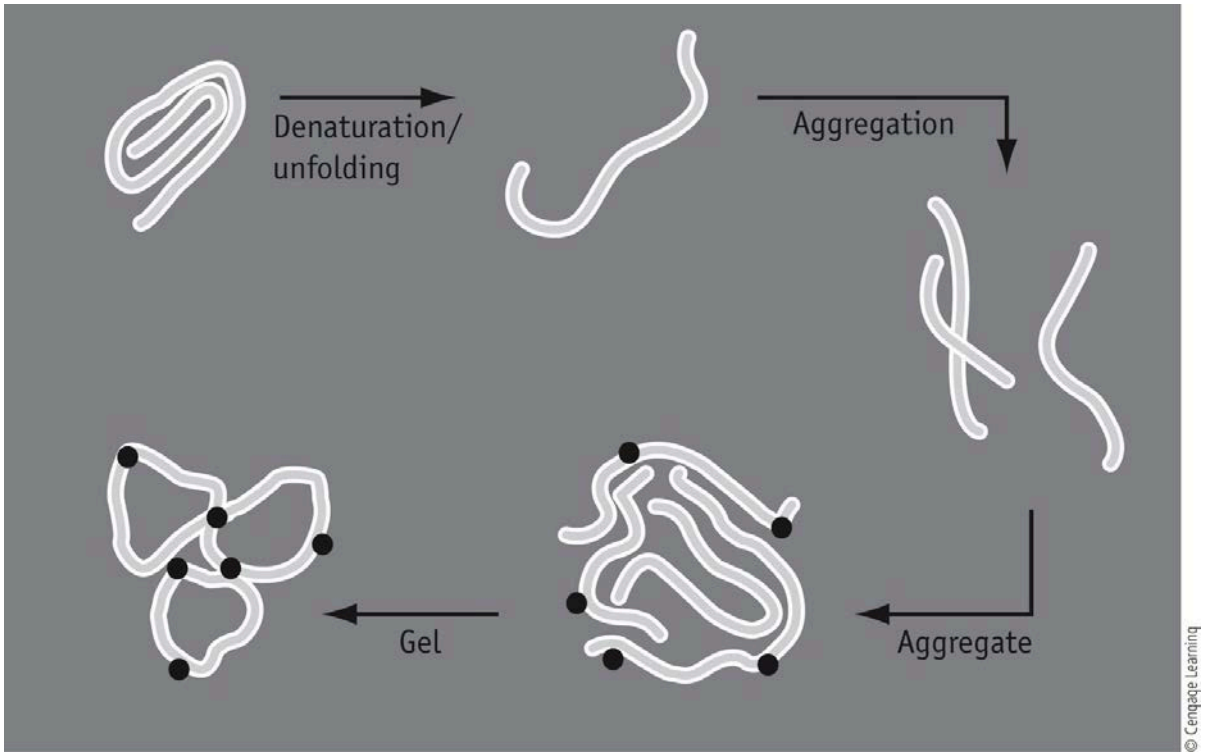


Thickening with long molecules: Gelatin and Starch

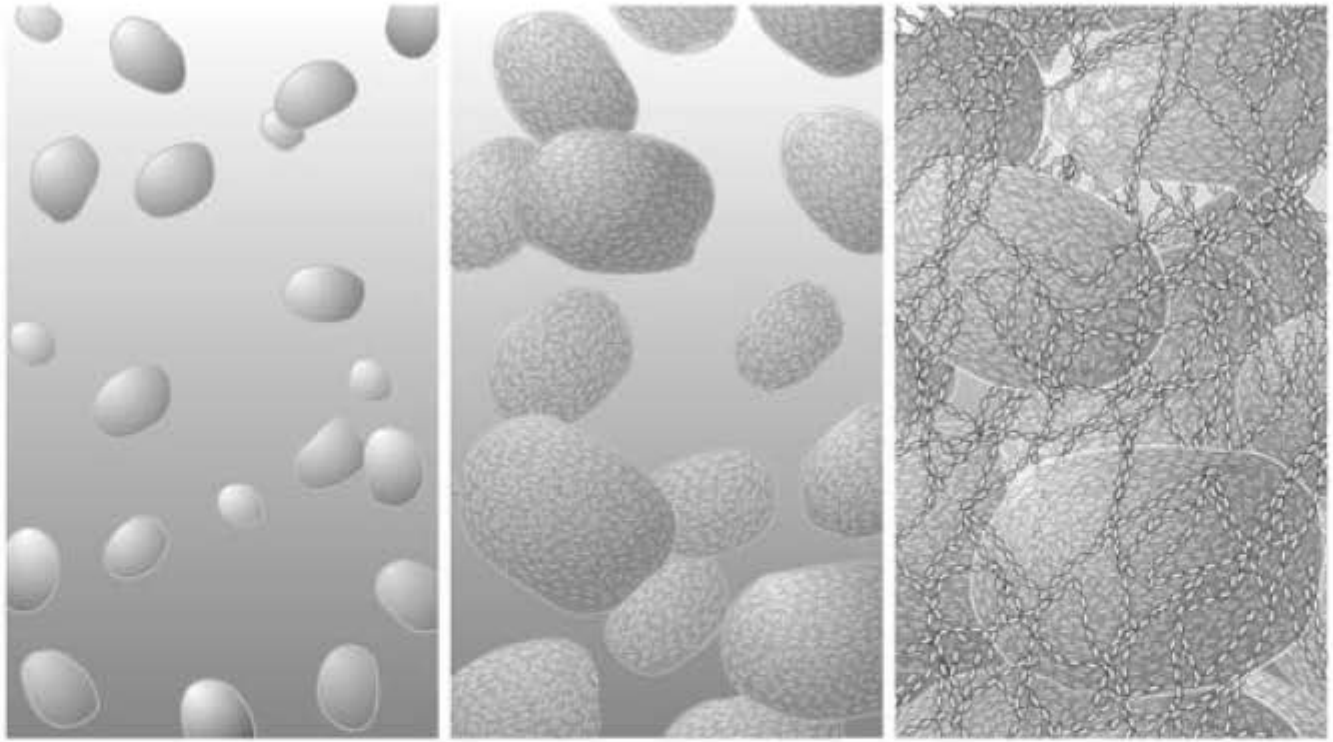


Thickening a liquid with long food molecules. Dissolved molecules of plant starch or animal gelatin get tangled up with each other and impede the flow of the liquid.

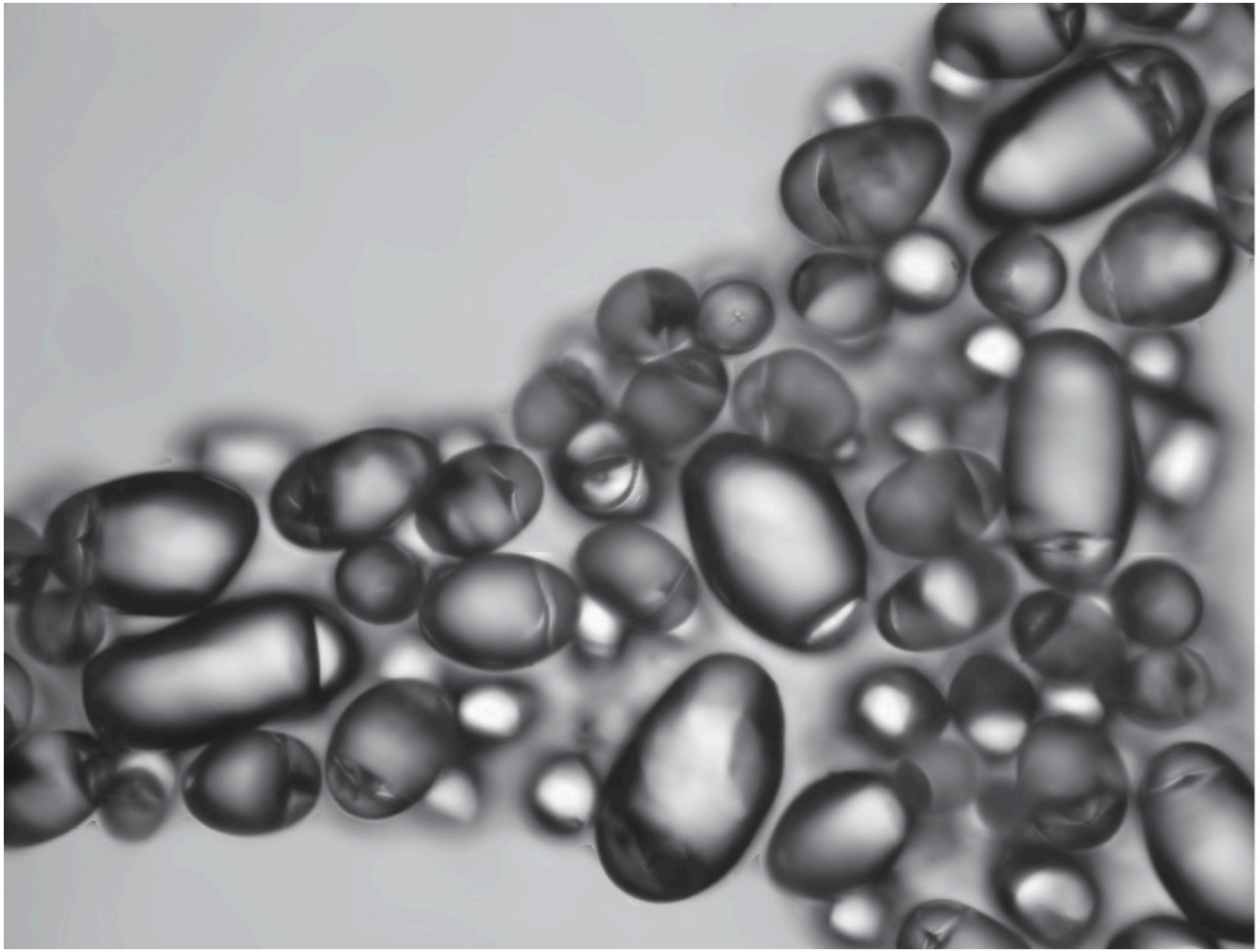
Gelatin


Denaturation/
unfolding
Aggregation
Aggregate
Gel
© Cengage Learning

Starch

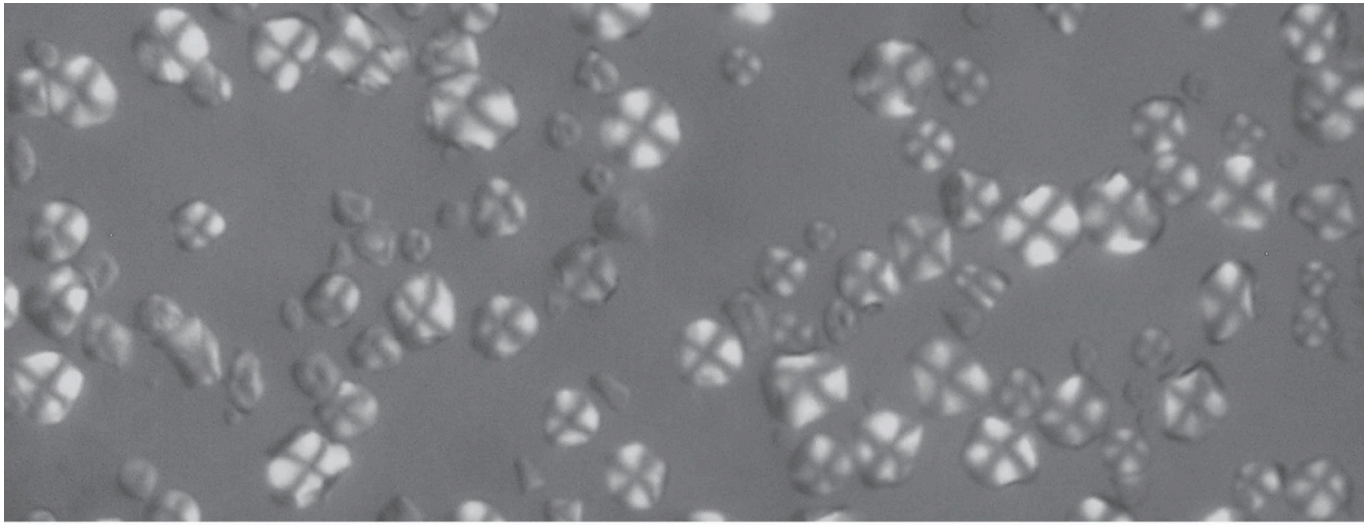


Thickening a sauce with starch. Uncooked starch granules offer little obstruction to the flow of the surrounding liquid (left). *As the sauce heats up and the temperature reaches the gelation range, the granules absorb water and swell, and the sauce consistency begins to thicken* (center). *As cooking continues and the temperature approaches the boil, the granules swell even more and leak starch chains into the liquid* (right). *It's at this stage that the sauce reaches its maximum thickness.*



Jubal Harshaw/www.shutterstock.com

Figure 18-1 p390



Source: Jan Homann

Figure 18-5 p394

Two types of Starch

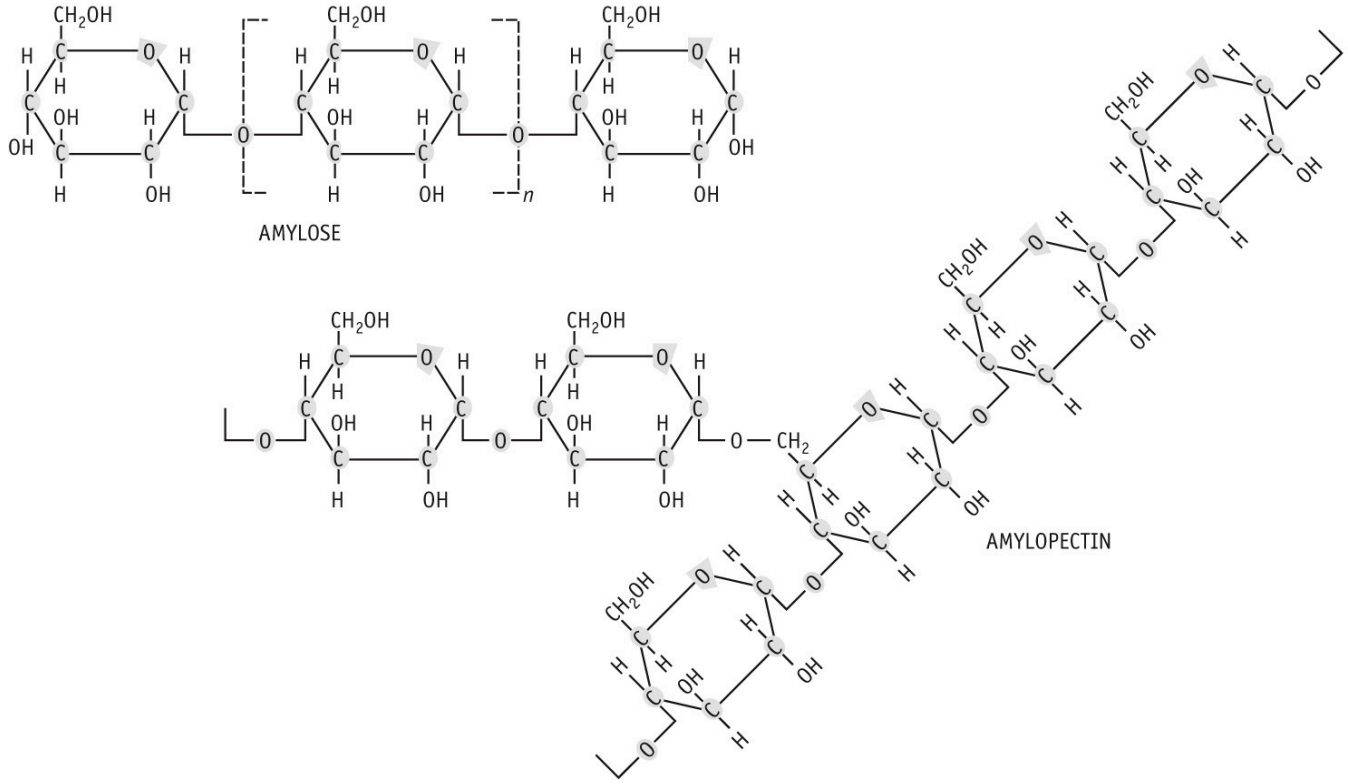
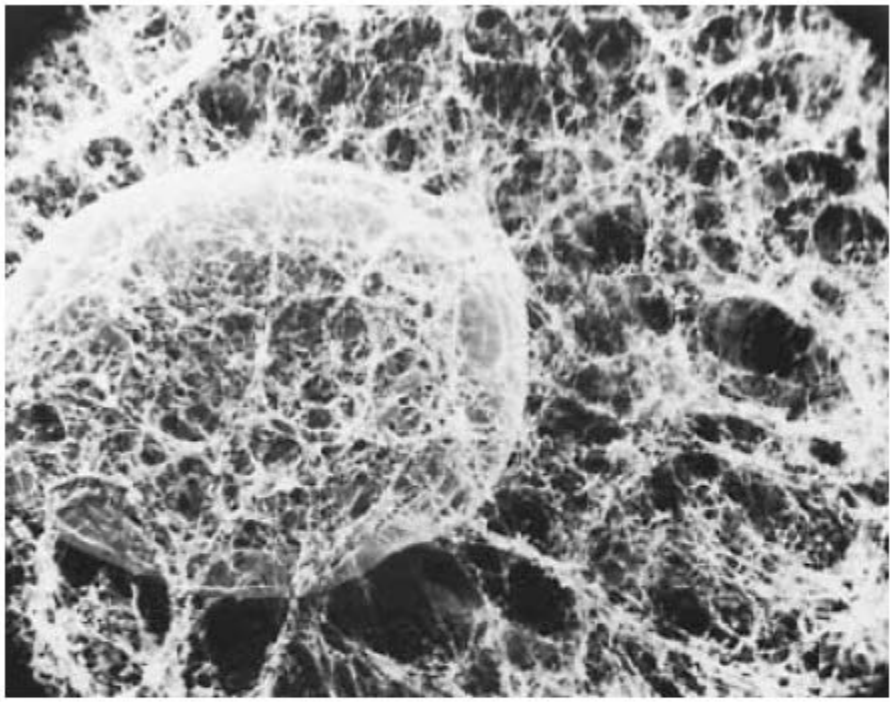
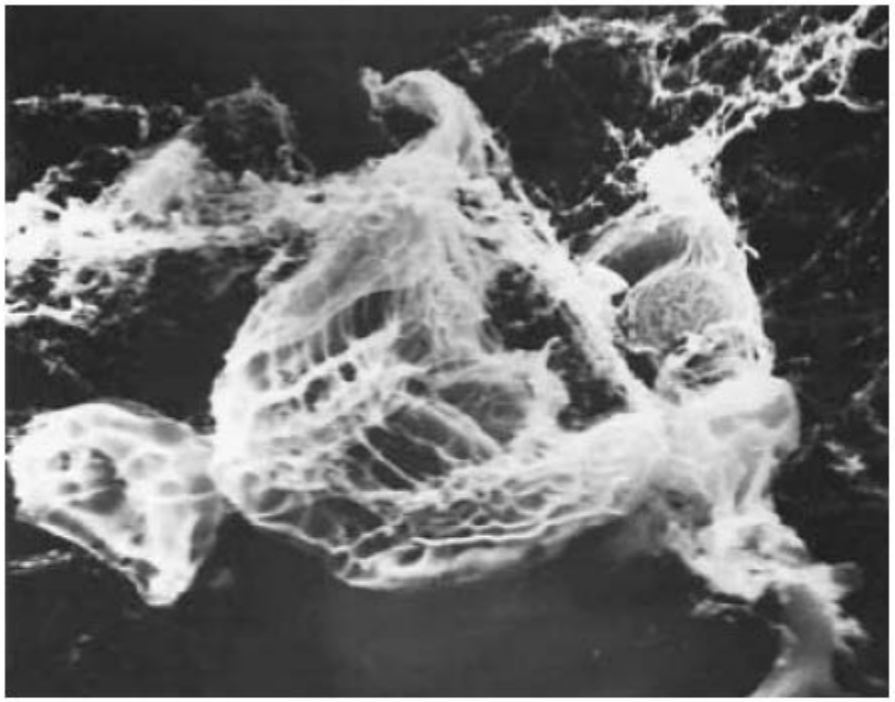


Figure 18-3 p391

Starch: Swellin' & Gellin'





Starch in sauce making. A swollen granule of potato starch caught in a meshwork of molecules freed from it and other granules (left). *A starch-thickened sauce is thickest at this stage, when both starch granules and molecules block the movement of water. A granule of wheat starch that has lost nearly all of its starch molecules to the surrounding liquid* (right). *As the granules in a starch-thickened sauce disintegrate, they no longer get caught in the mesh of free starch, and the sauce thins out.*

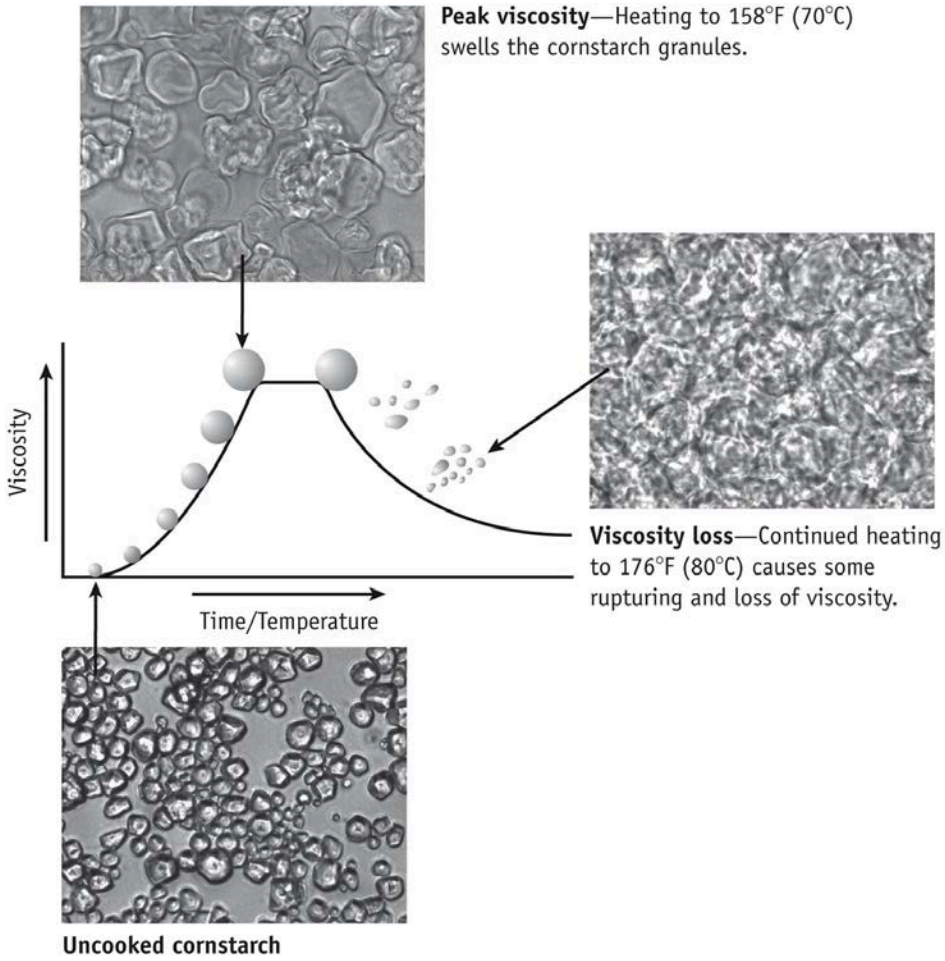


Figure 18-4 p393


EGGS!
EGGS!
EGGS!
EGGS!
EGGS!
EGGS!
EGGS!

How many calories are the judges about to consume?

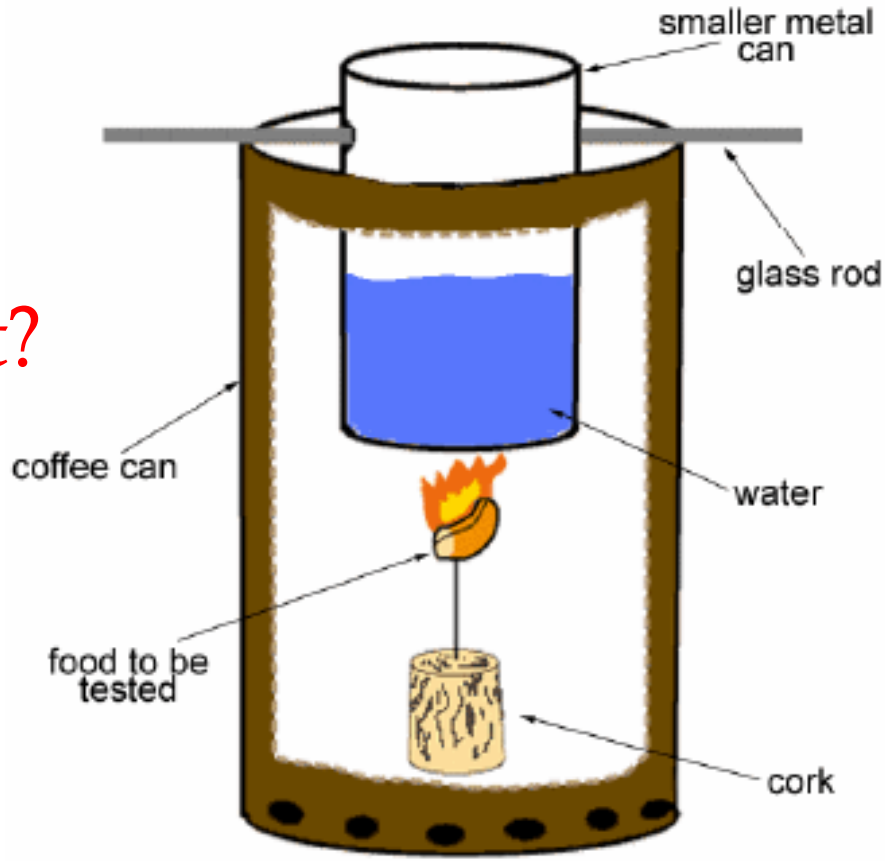
How many calories are the judges about to consume?

What is a calorie?

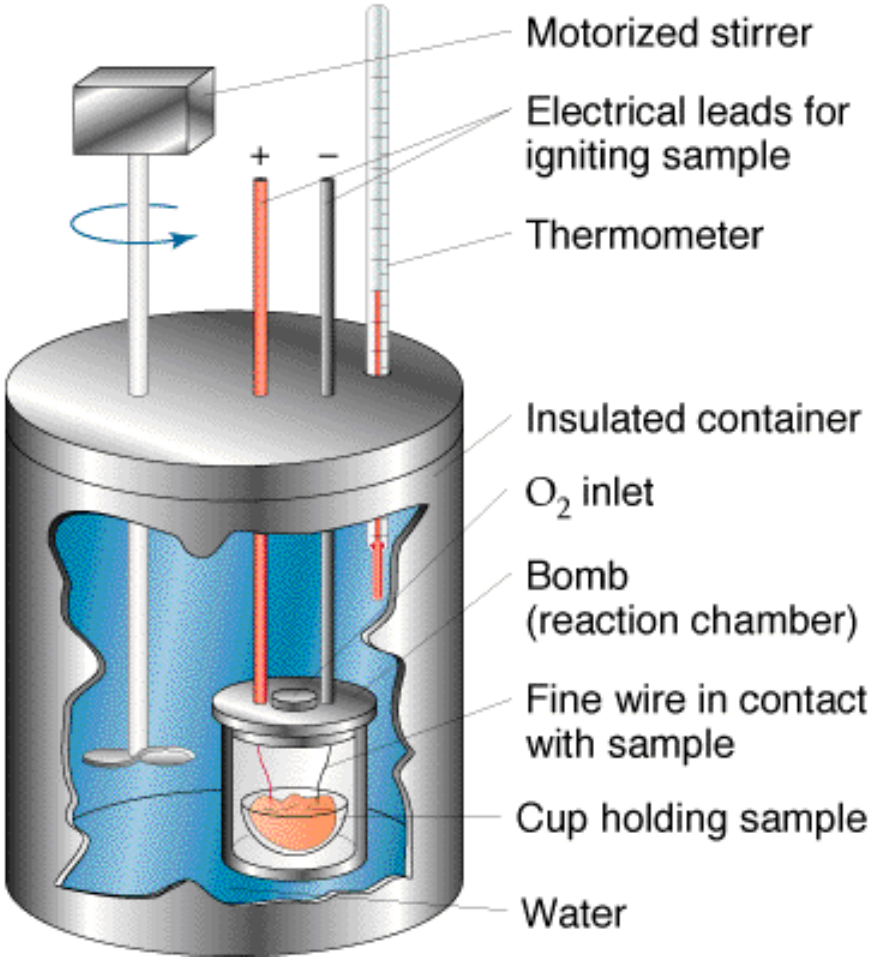
How many calories are the judges about to consume?

What is a calorie?

How do we measure it?



How is Heat Transfer Determined in Research Labs?



Bomb Calorimeter

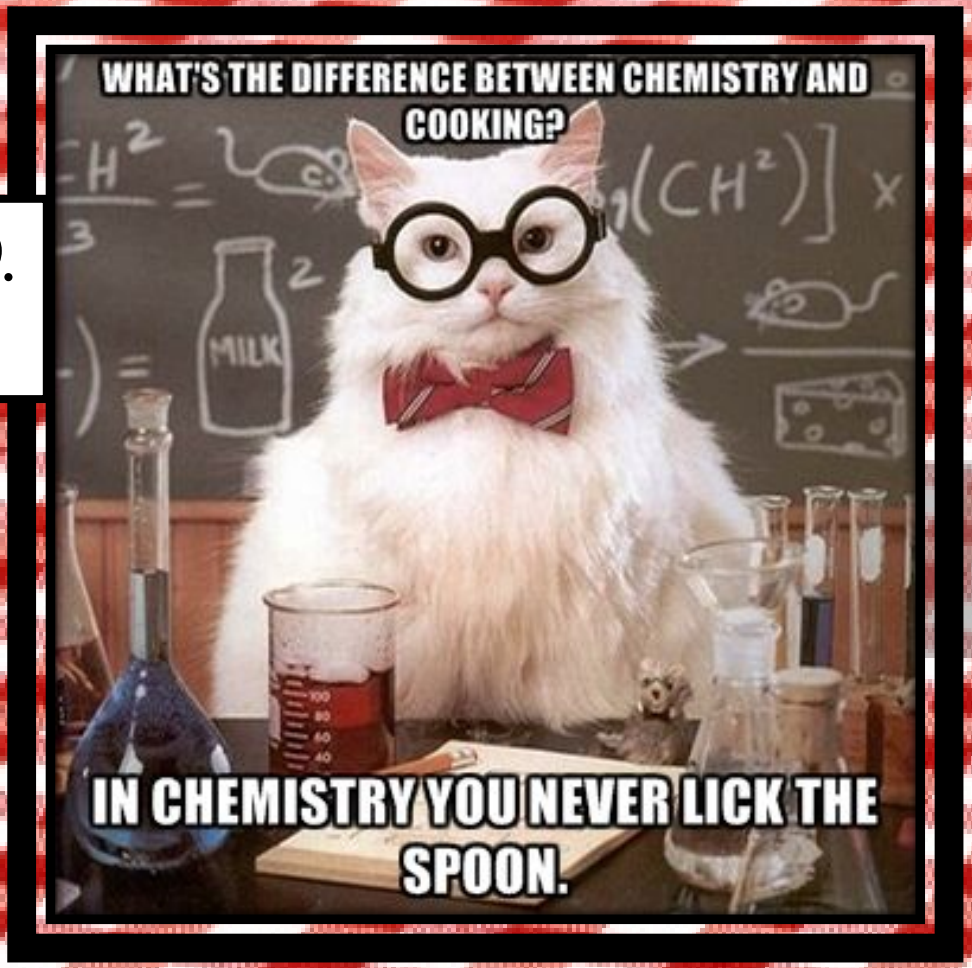
Judging Criteria

Criteria	Score
Taste (1 to 4)	
Originality (1 to 4)	
Use of secret ingredient (1 to 4)	
Scientific interest (1 to 4)	
Visual Presentation (1 to 4)	
Sub total	

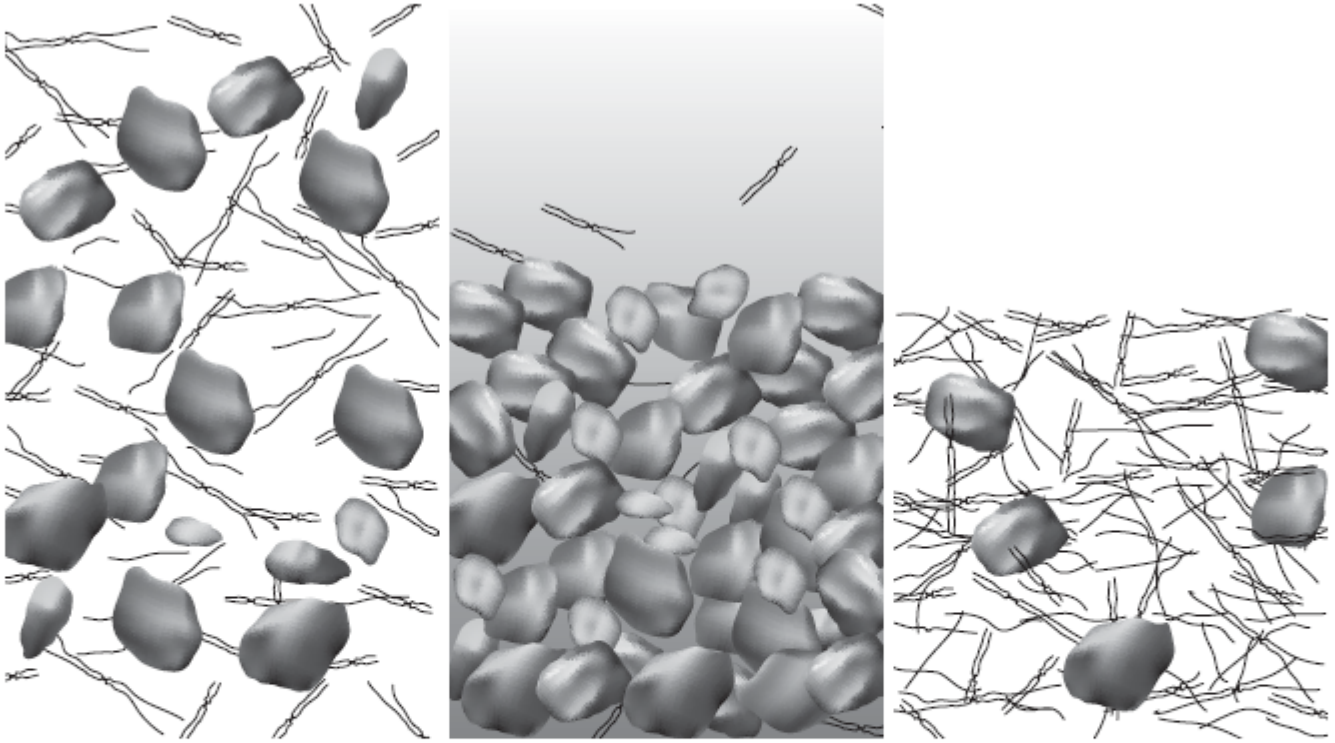
Culinary Chemistry: A Campus Cuisine Cookoff

MSUB Library Lecture series
Spring 16

Michele McMullen R.D.
Dr. Matt Queen



Puree: Smashing cells



A fruit or vegetable puree. Grinding plant tissue turns it inside out, freeing the cell fluids and breaking the cell walls and other structures into small particles. A puree is a mixture of plant particles and molecules floating in water (left). *If left to stand, most purees will separate, with the larger particles settling to the bottom* (center). *This separation can be prevented, and the puree consistency thickened, by cooking the puree down and evaporating the excess water* (right).

(1) Sauté aromatic vegetables (onions, garlic, shallots, or leeks) over medium heat. Adding herbs such as thyme, sage, or rosemary improves flavor.

(2) Pour in the liquid (water, broth, milk, or a combination) and heat to a simmer. Use 5 to 6 cups of liquid for every 2 pounds of main vegetable to be added.

(3) Add a thickener in the form of rice (½ cup) or raw potato (sliced). Starchy ingredients thicken when they gelatinize, making the soup feel creamy.

(4) The time to add the main vegetable (in even, bite-size pieces) is when the time remaining to cook the thickener is equal to how long it will take to cook the vegetable.

(5) When the thickener reaches its maximum viscosity, purée the soup in batches using a blender or food processor. Another option is to strain the soup to obtain a finer texture.

(6) Finishing touches include adding a little liquid to thin the purée if it is too thick, and/or adding a small amount of cream to give it a "cream" flavor. Serve hot or cold.

Digital Works

Figure 15-4 p332

TABLE 18-5 Selected Small Sauces Derived from Mother Sauces

Mother Sauces	Base Ingredient	Small Sauces
Béchamel (white) sauce	Milk	Cheddar cheese Cream Mornay Mustard
Espagnole (brown) sauce	Brown stock	Mushroom
Hollandaise sauce	Butter	Maltaise Mousseline
Tomato sauce	Tomato	Creole Portuguese Spanish
Velouté sauce	White stock Chicken stock Fish stock	Curry Mushroom Herb

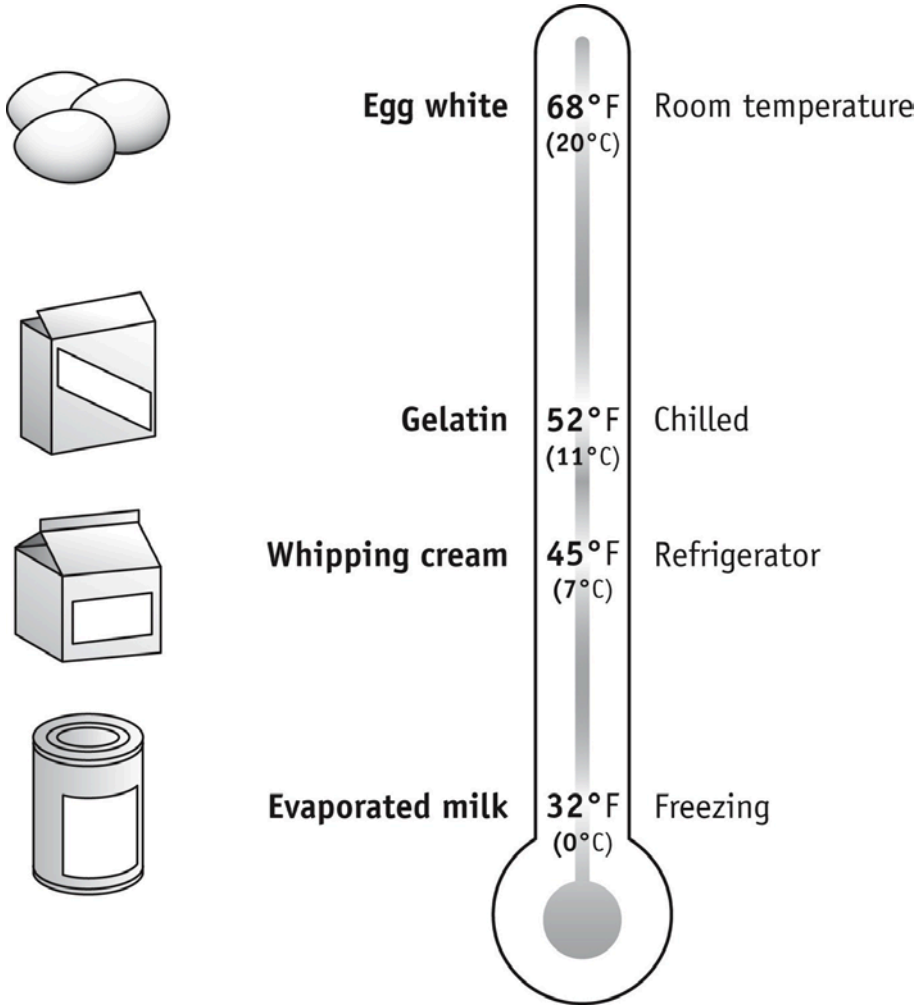


Figure 10-9 p227