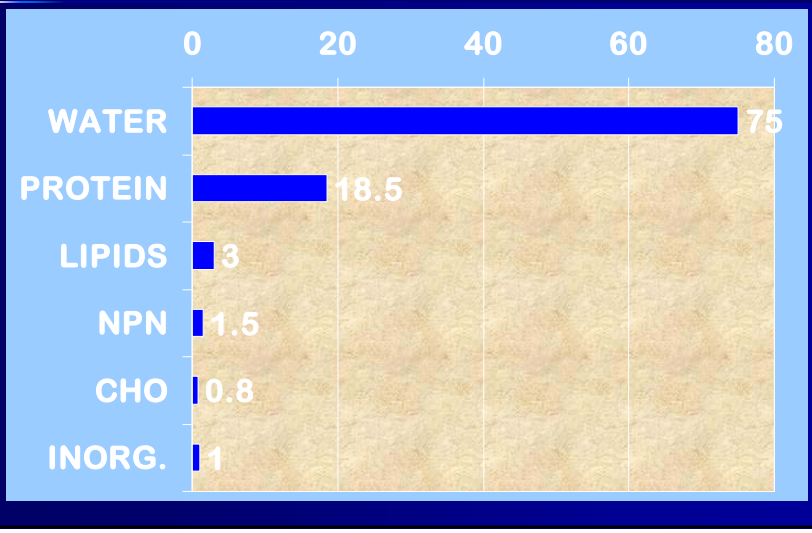
Muscle Composition

ANSC 4400

Composition of Muscle



Water

- Varies inversely with fat content
  - Muscles with more fat contain less water
  - Typical range = 65 to 80 percent
    - Carrier of intra- and inter-cellular constituents

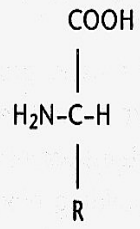
Protein

- Averages 18.5% in muscle
- Is least variable component
- Is the most important component
- Is the food component in shortest supply in food supply (world)

Protein

- Composed of amino acids with following basic structure:

All amino acids have the following basic structure:



Amino Acids

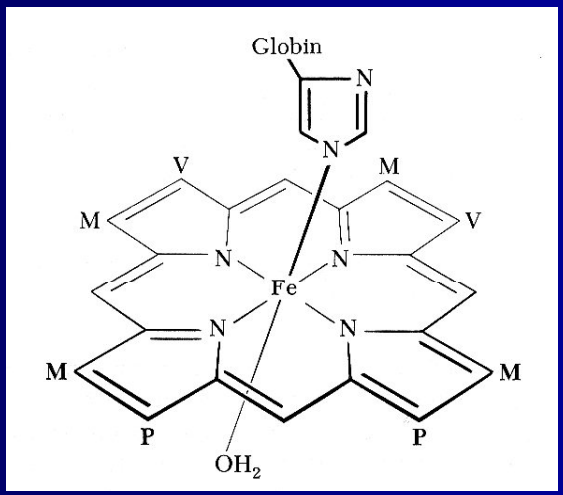
Table 23–1. Amino Acids

Essential	Nonessential	Less Common, Nonessential
Histidine (His)	Alanine (Ala)	Cystine $(Cys)_2$
Isoleucine (Ile)	Arginine (Arg)	Hydroxyproline (Hyp)
Leucine (Leu)	Asparagine (Asn)	Hydroxylysine (Hyl)
Lysine (Lys)	Aspartic acid (Asp)	Citrulline
Methionine (Met)	Cysteine (Cys)	B-alanine
Phenylalanine (Phe)	Glutamine (Gln)	Aminobutyric acid
Threonine (Thr)	Glutamic acid (Glu)	Diaminopimelic acid
Tryptophan (Trp)	Glycine (Gly)	Dihydroxyphenylalanine
Valine (Val)	Proline (Pro)	Ornithine
	Serine (Ser)	Taurine
	Tyrosine (Tyr)	

Types of Protein

- Myofibrillar – 9.5%
  - Myosin and actin
- Sarcoplasmic – 6%
  - Enzymes and pigments
  - Mb and Hb
  - Functional roles
  - Globular

Myoglobin



Types of Proteins

- Stromal – 3%
  - Connective tissues
  - Collagen, elastin, reticulin
- Collagen
  - Most abundant protein in body
  - Increase age, what happens?
  - Degrades to gelatin at 65 degrees C

Types of Proteins

- Elastin
  - Does not degrade to gelatin
  - Example is *ligamentum nuchae*
  - Imparts elasticity in arterial walls

Lipids – Fats and Oils

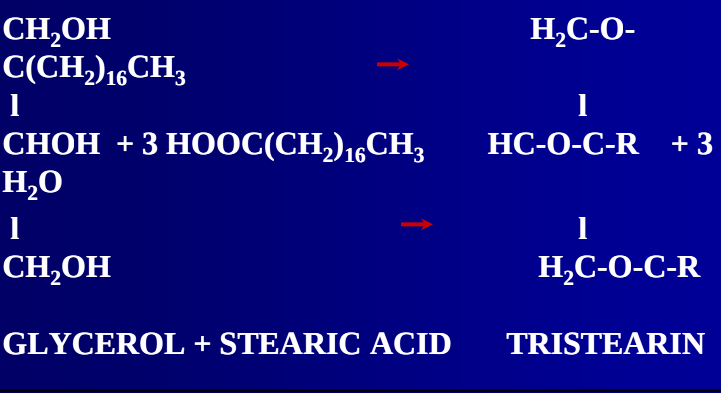
- Influence flavor, juiciness, and calorie content
- Averages 3% in muscle
- Cattle with higher marbling scores = higher or lower fat content?

Kinds of Lipids

- NEUTRAL LIPIDS - 1%
- PHOSPHOLIPIDS - 1%
- CHOLESTEROL - 0.5%

NEUTRAL LIPIDS

Tryglycerides = 3 mole of fatty acid attached to a glycerol



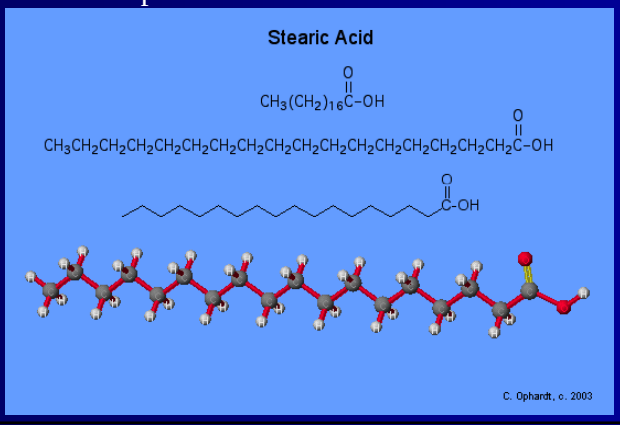
KINDS OF TRIGLYCERIDES

- If the same kind of fatty acid occupies all three positions on the glycerol molecule, the result is a simple triglyceride.
- If more than one kind of fatty acid is attached to glycerol, the result is a mixed triglyceride.
- What determines what kinds of tri- glycerides an animal manufactures?

SATURATED FATTY ACIDS

Stearic Acid – Saturated Fatty Acid

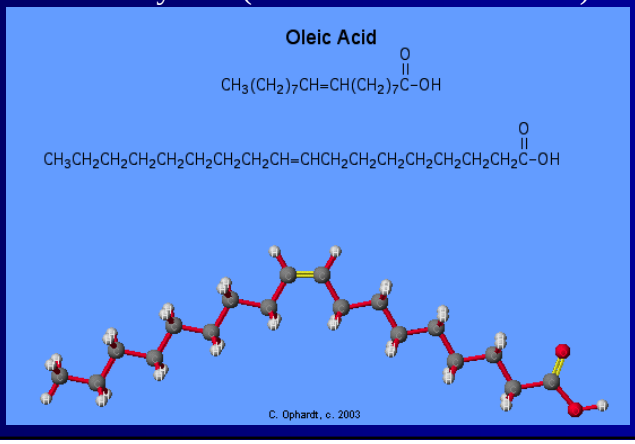
- No double bonds between carbon atoms
- Third most predominant FA in meat animals



UNSATURATED FATTY ACIDS

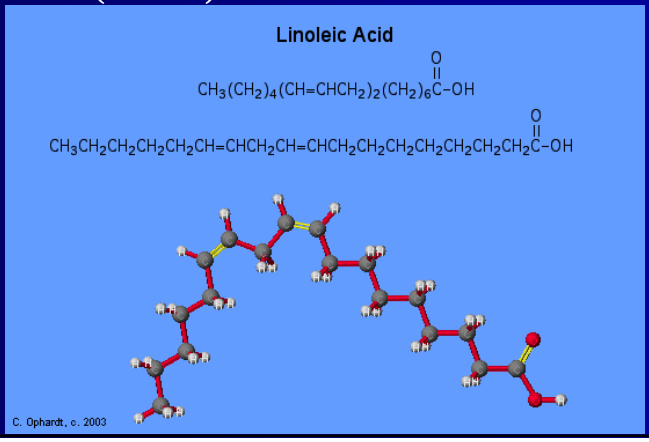
OLEIC ACID :

- The most prevalent fatty acid in animal fats
- Mono-saturate fatty acid (contains one double bond)



Polyunsaturated Fatty Acids

- Linoleic Acid
  - Polyunsaturate fatty acid
  - Has two (or more) double bonds



Reactivity of Fatty Acids

- Unsaturated fatty acids are more reactive
- O_2 attaches at double bonds
  - Results in rancidity and oxidation

Melting Points of Some Fats

Pork	
Backfat	86°–104°F
Leaf fat	110°–118°F
Beef	
External fat	89°–110°F
Kidney fat	104°–122°F
Lamb	
External fat	90°–115°F
Kidney fat	110°–124°F
Poultry	
Abdominal fat	80°–110°F

WHY THE RANGES AND SPECIES DIFFERENCES?

In General:

- Fats with longer carbon chains and more saturation have higher melting points.
- Internal fats are more saturated and have higher melting points than external fats
- Why?

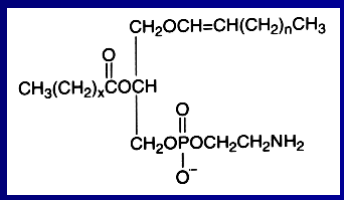
What practical difference does melting point of fats *per se* make in animal bodies and in industry?

The Third Kind of Lipids

- Phospholipids - compounds containing phosphorus and lipids

  An example is ethanolamine

Function in rancidity development in fats.



The Fourth Kind of Lipids

- Cholesterol - that much maligned, essential dietary component.
- Required for hormone function and cell wall integrity.
- About 20% of body needs is consumed whereas, 80% is manufactured.
- If we don't eat enough, our bodies manufacture more.
- Contrary to popular belief, cooked meats of different species vary little in cholesterol content.

NPN – Non - Protein Nitrogen

- About 1.5% in muscle
- Molecules contain nitrogen but are not proteins
- Some NPN compounds contribute to meat flavor
- NPN example
  - ATP (Adenosine triphophate)

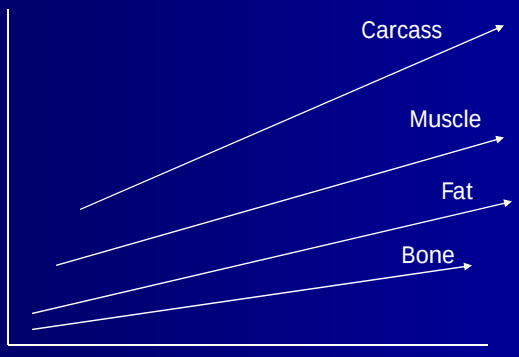
CHO - Carbohydrates

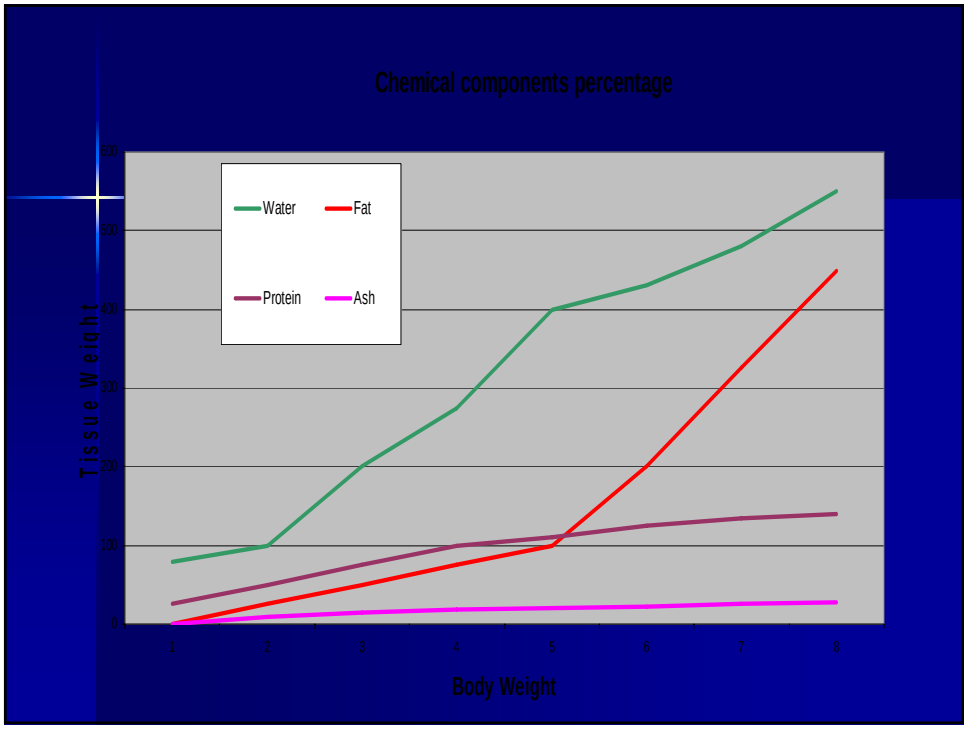
- About 1% (0.8%) found in muscle
  - ranges from 0.5 - 1.5% in muscle.
- Although low in amount, CHO's play large roles in meat properties and appearance.
- Best example is Glycogen
  - storage form composed of glucose units

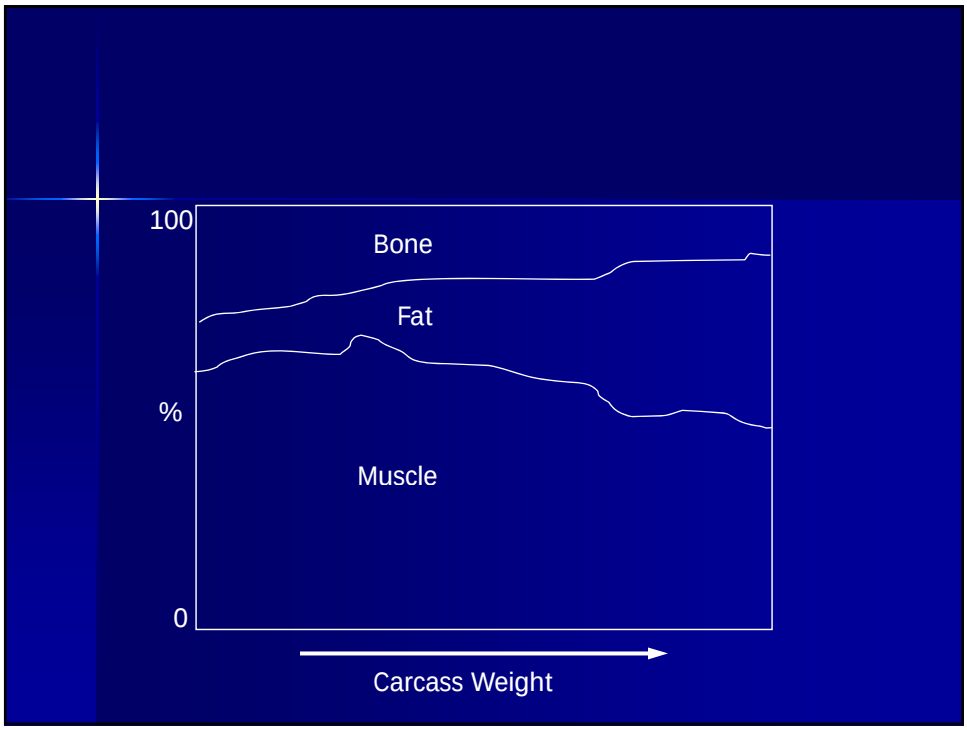
Inorganic Compounds - Minerals

- About 1% in muscle
- Measured as ash after burning samples in a muffle furnace
- Meat (particularly beef) is a good source of some minerals, particularly Fe and Zn.
- Fe in meat is in a heme form that is more readily available than fe from plants.
- Zn is in many enzymes and hormones, including sex hormones.

Individual Compositional Components




Chemical components percentage
Water
Fat
Protein
Ash
Tissue Weight
0
100
200
300
400
500
600
1
2
3
4
5
6
7
8
Body Weight


100
Bone
Fat
%
Muscle
0
Carcass Weight

Fat Partitioning

1. Mesenteric
2. KPH
3. Intermuscular
4. Subcutaneous
5. Intramuscular

Measuring Carcass Composition

- Direct Method
  - Ideal reference endpoint – where there are no limitations on cost, time, labor
    - Chemical analyses of carcass tissues
  - Predictors – depend on objectives and resources
    - Biological – whole body chemical comp
    - Economical
      - Edible product, saleable product, etc

Measuring Carcass Composition

- Indirect Method
  - Linear measurements
  - Specific gravity
  - Ultasound
  - Probes
    - Thermistor – temp
    - Ulster – color
    - Danish meat-fat automatic probe – electrical
    - Hennessy Probe – fat depth

Muscle Fiber Types

Characteristics	Type 1	Type 2A	Type 2X(D)	Type 2B
Reddness	++++	+++	+	+
Myoglobin content	++++	+++	+	+
Fiber diameter	+	+	+++	++++
Contraction speed	+	+++	+++	++++
Fatigue resistance	++++	+++	+	+
Contractile action	tonic	tonic	phasic	phasic
Number of mitochondria	++++	+++	+	+
Mitochondria size	++++	+++	+	+
Capillary density	++++	+++	+	+
Oxidative metabolism	++++	++++	+	+
Glycolytic metabolism	+	+	+++	++++
Lipid content	++++	+++	+	+
Glycogen content	+	+	++++	++++
Z disk width	++++	+++	+	+

* The characteristics are relative to the other fiber types.

Book Reading

- Pages 36 – 43
- Table 2.2
- Table 2.3