Food Material Science 2012/2013
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M E A T

INTRODUCTION

- *'Meat is the post-mortem aspect of the 300 or so anatomically distinct muscles of the body, together with the connective tissue in which the muscle fibres are deposited and such intermuscular fat as cannot be removed without disrupting the muscle as a whole'.*

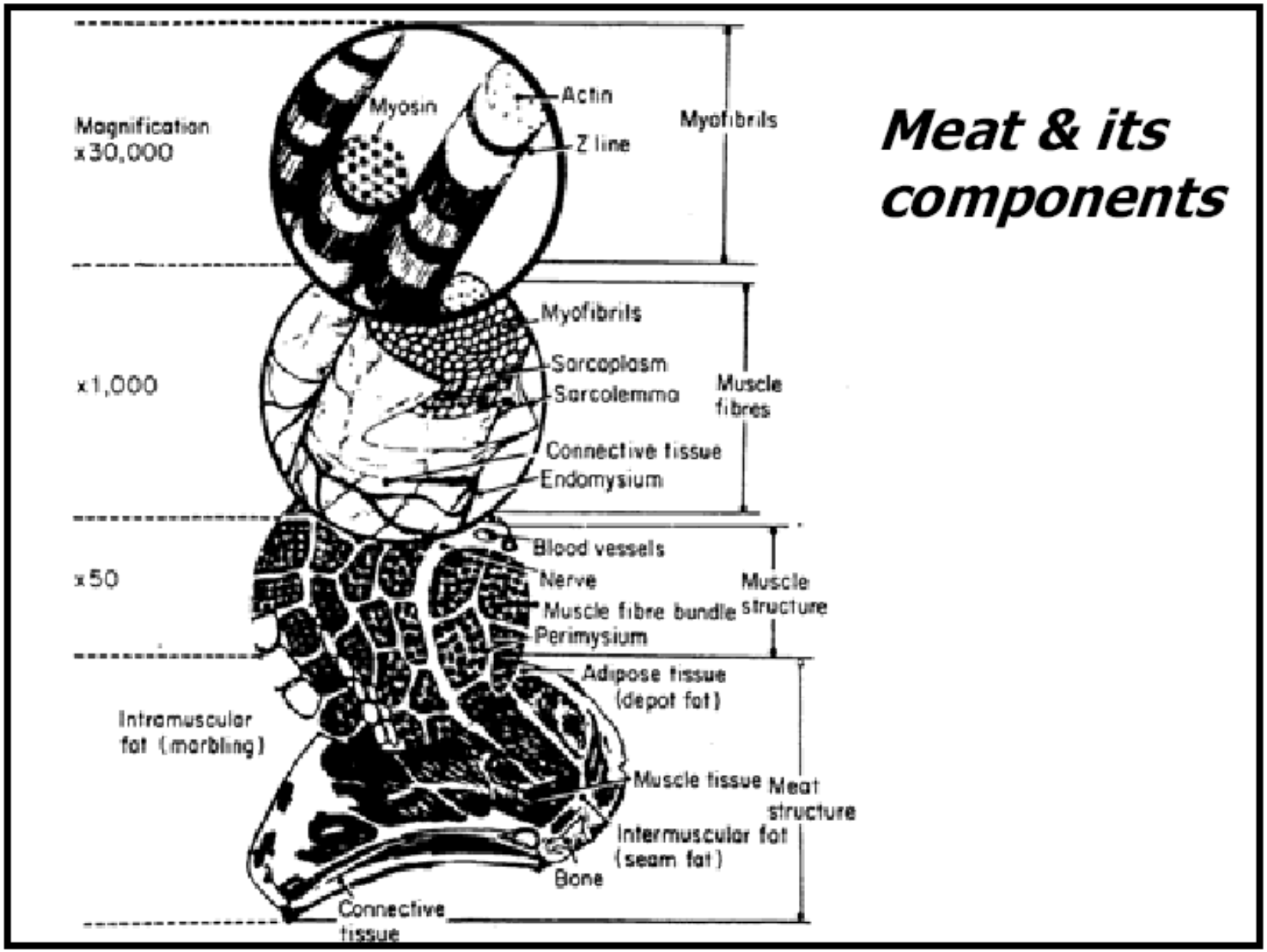
- *Meat refers to the skeletal muscle from the carcasses of animals – cattle (beef, veal), pork, and lamb (sheep).*

General Composition of Meat

- 20% protein
- 8% fat
- 1-2% glycogen (carbohydrate)
- 1% ash
- 70% water

Species	Composition (%)			
	Water	Protein	Lipid	Ash
Beef	70-73	20-22	4-8	1
Pork	68-70	19-20	9-11	1.4
Lamb	73	20	5-6	1.6

Meat Components



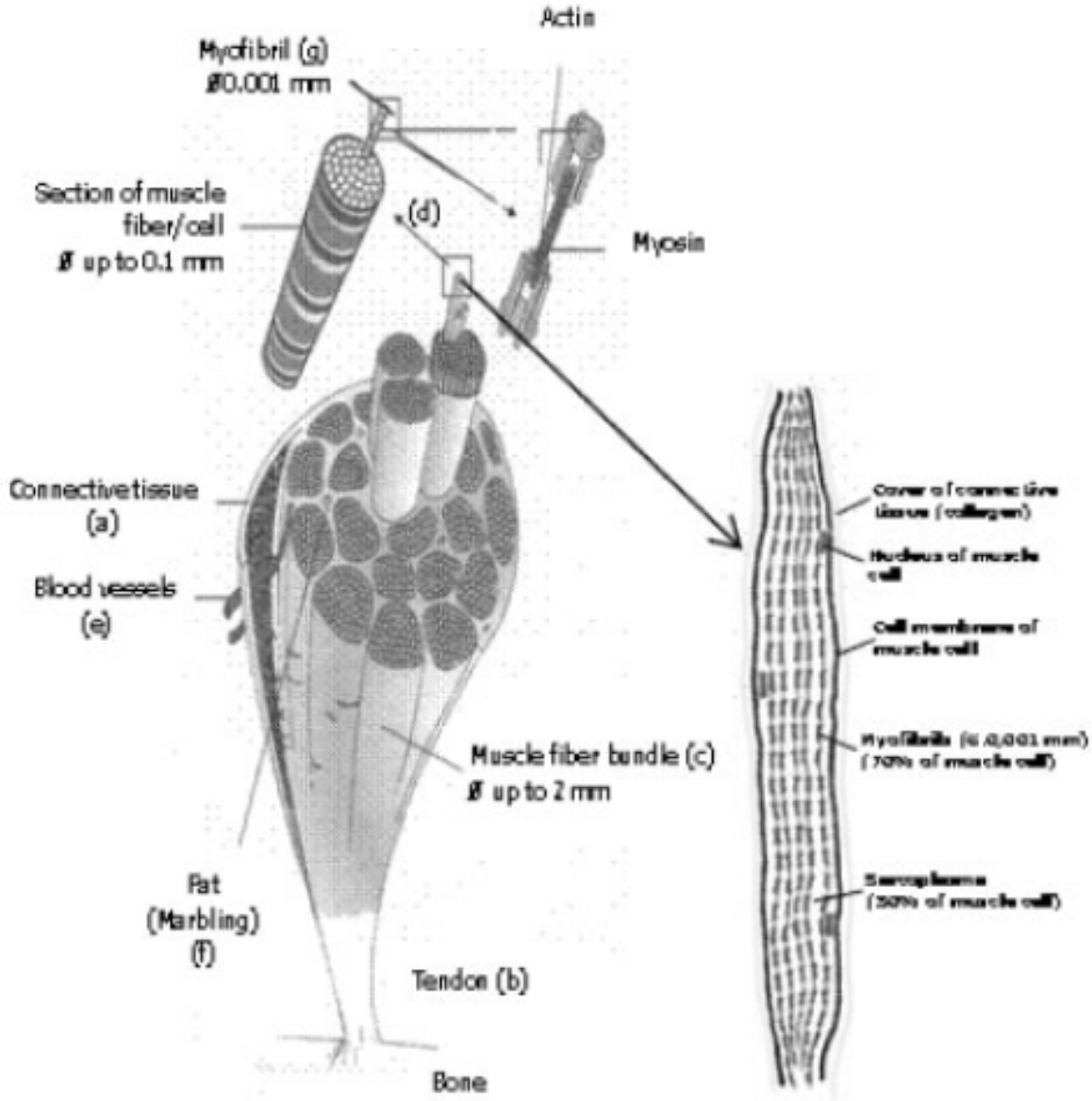


Fig. 1: Muscle structure (skeletal muscle)

Fig. 2: Entire muscle fibre or muscle cell, 0.01-0.1 mm

- Muscle fibres are long, multinucleated cells and are also aclled myofibres, or simply fibres.
- Myofibres are tipically 40 – 50 μm in diameter and several mm long (1 – 40 mm).
- Each myofibre is enveloped in connective tissue (endomysium) and myofibres are arranged longitudinally into bundles which are enveloped in thin sheet connective tissue (perimysium).
- Smaller bundle (primary bundles) are grouped into larger bundles, which may be grouped into even larger tertiary bundles.

- Entire muscles are covered by a heavy sheath of connective tissue (epimysium). This thickens as it blends into tendon.
- The three of connective tissues (epi-, peri,- and endomysium) are continuum which mainly consist of fibrous proteins – collagens.

Parameters of Meat Quality

	Acceptable	**Unacceptable**
Appearance		
Meat color	Red / pink	Brown, grey green
Fat color	White	Yellow
Texture	Firm	Soft, mushy, dry
Weep	None	Any exudate
Palatability		
Tenderness	Tender	Mushy, tough
Flavor	Typical of sp.	Boar taint, rancid, acid taste
Juiciness	Moist	Lack of flavor

(Laird, 2006)

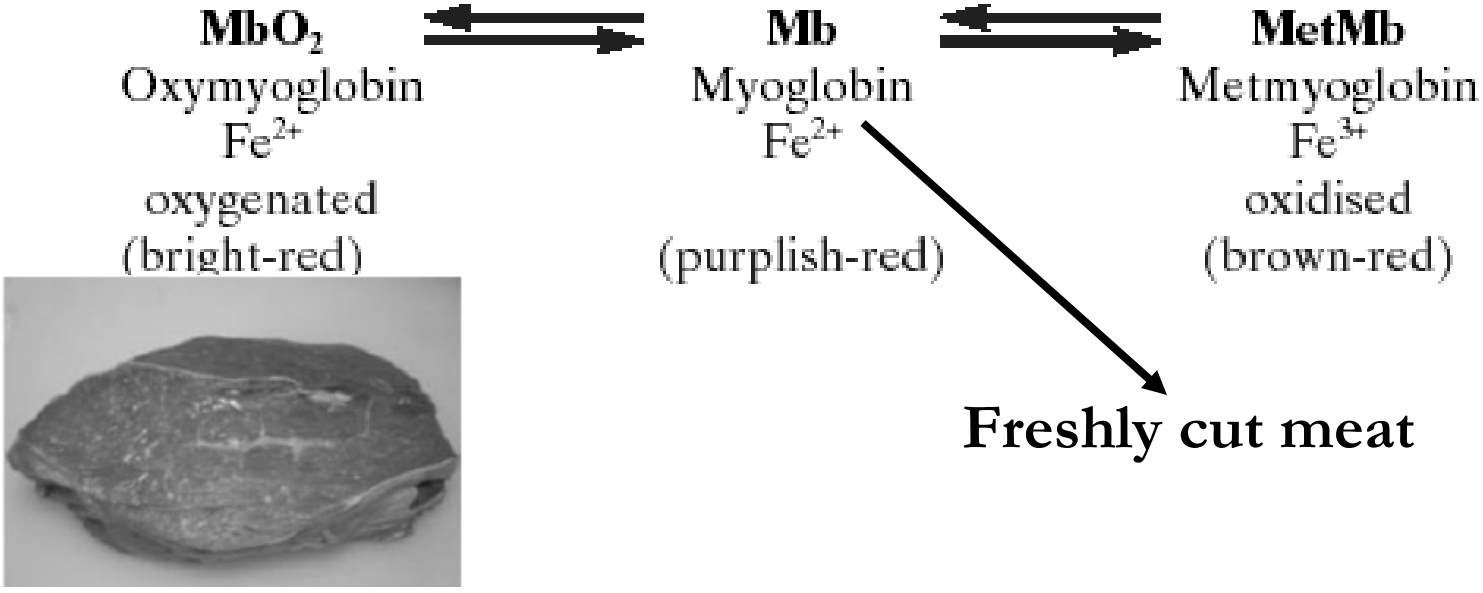
Meat Color

- Color is often the primary consumer identifier of meat quality and acceptability.
  - Fresh meat to be bright cherry red
  - Cooked meat to be brown/gray colored
  - Cured meat to be pink

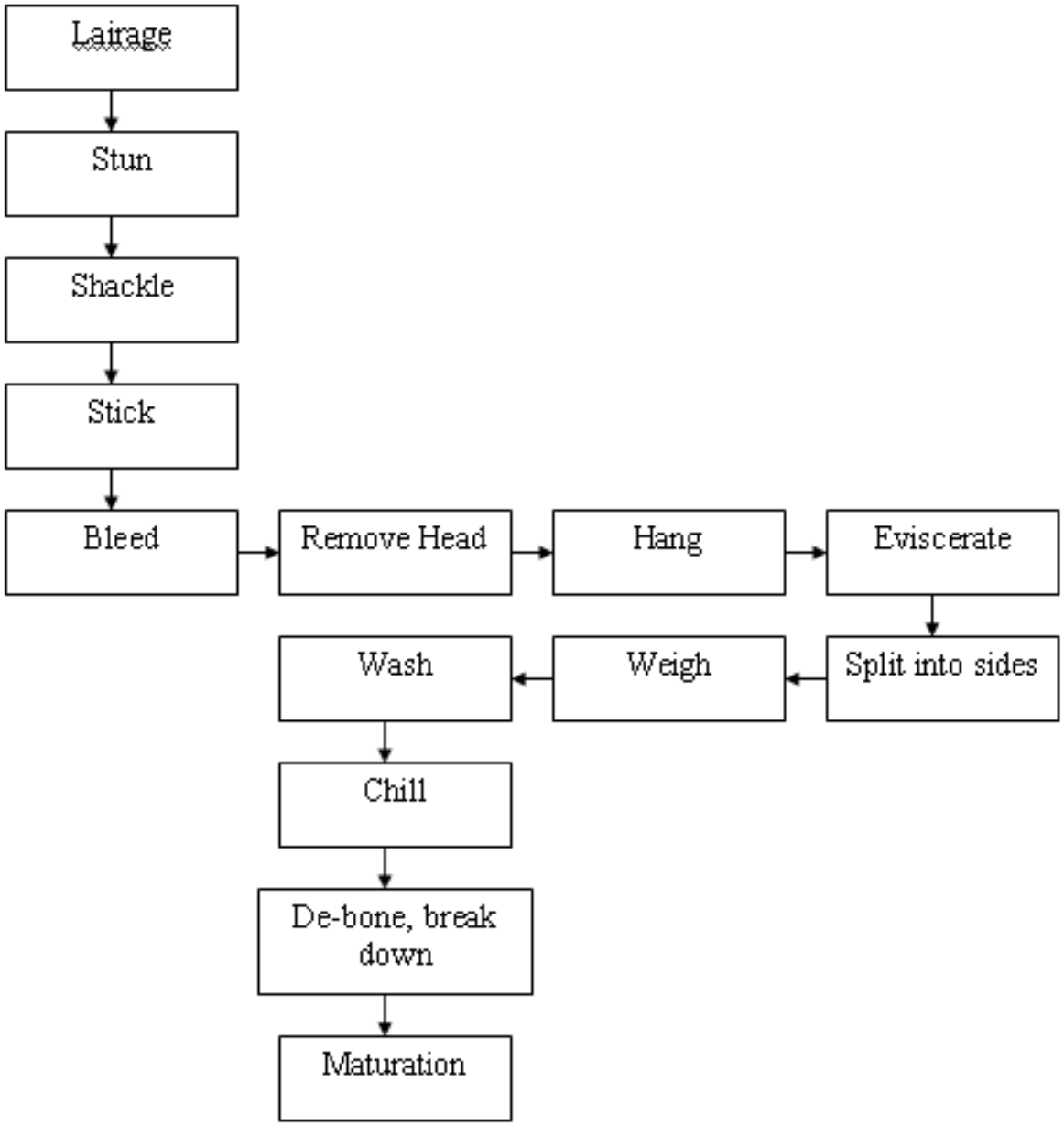
- Meat pigments:
  - Myoglobin --- the basic pigment of the fresh meat.
  - Haemoglobin --- only in small amounts.

Color of Fresh Meat

- In fresh meat, myoglobin can be found in different forms including:
  - bright-red oxymyoglobin (MbO2),
  - purple-red deoxymyoglobin (Mb), or
  - brown metmyoglobin (MetMb)



Slaughtering and Dressing of Cattle

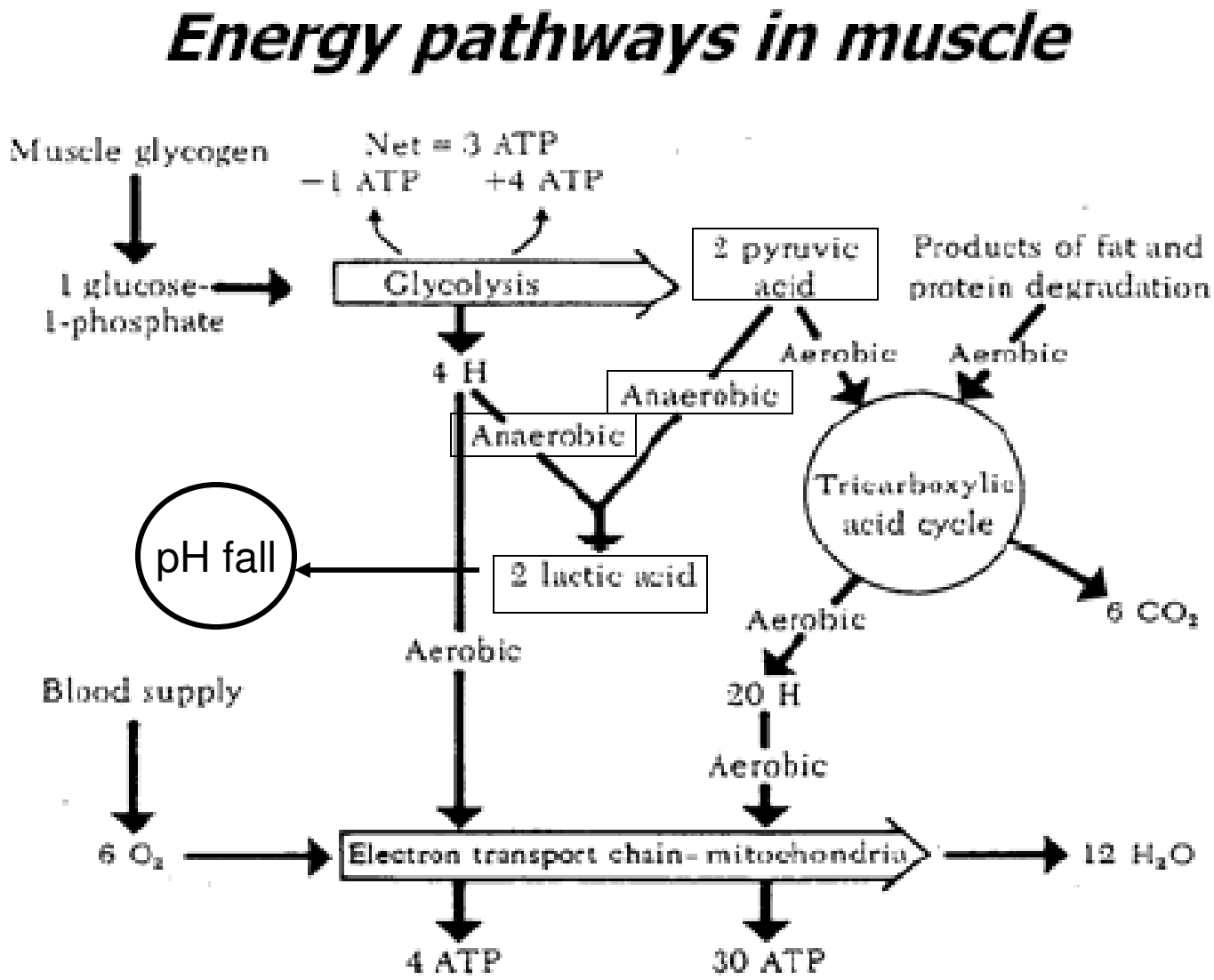


Varnam & Shutterland (1992)

POST MORTEM CHANGES

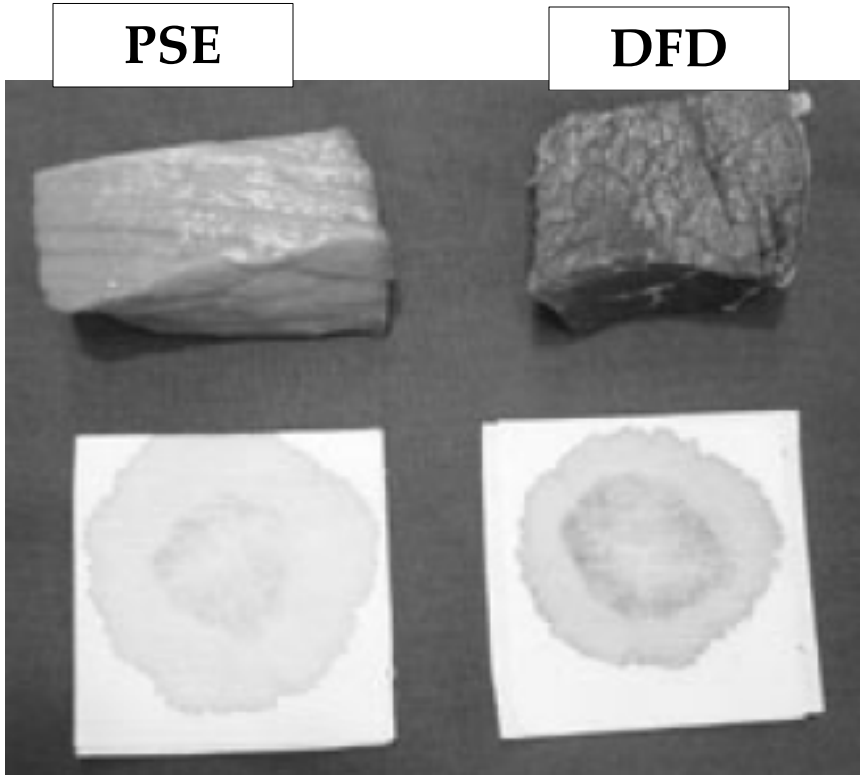
- Immediately after slaughter, many changes take place in muscle that convert muscle to meat.
- One of the changes is the contraction and stiffening of muscle --- **rigor mortis**.
- Muscle is very tender at the time of slaughter. But when rigor mortis begins, muscle becomes progressively less tender until rigor mortis is complete.

POST MORTEM CHANGES



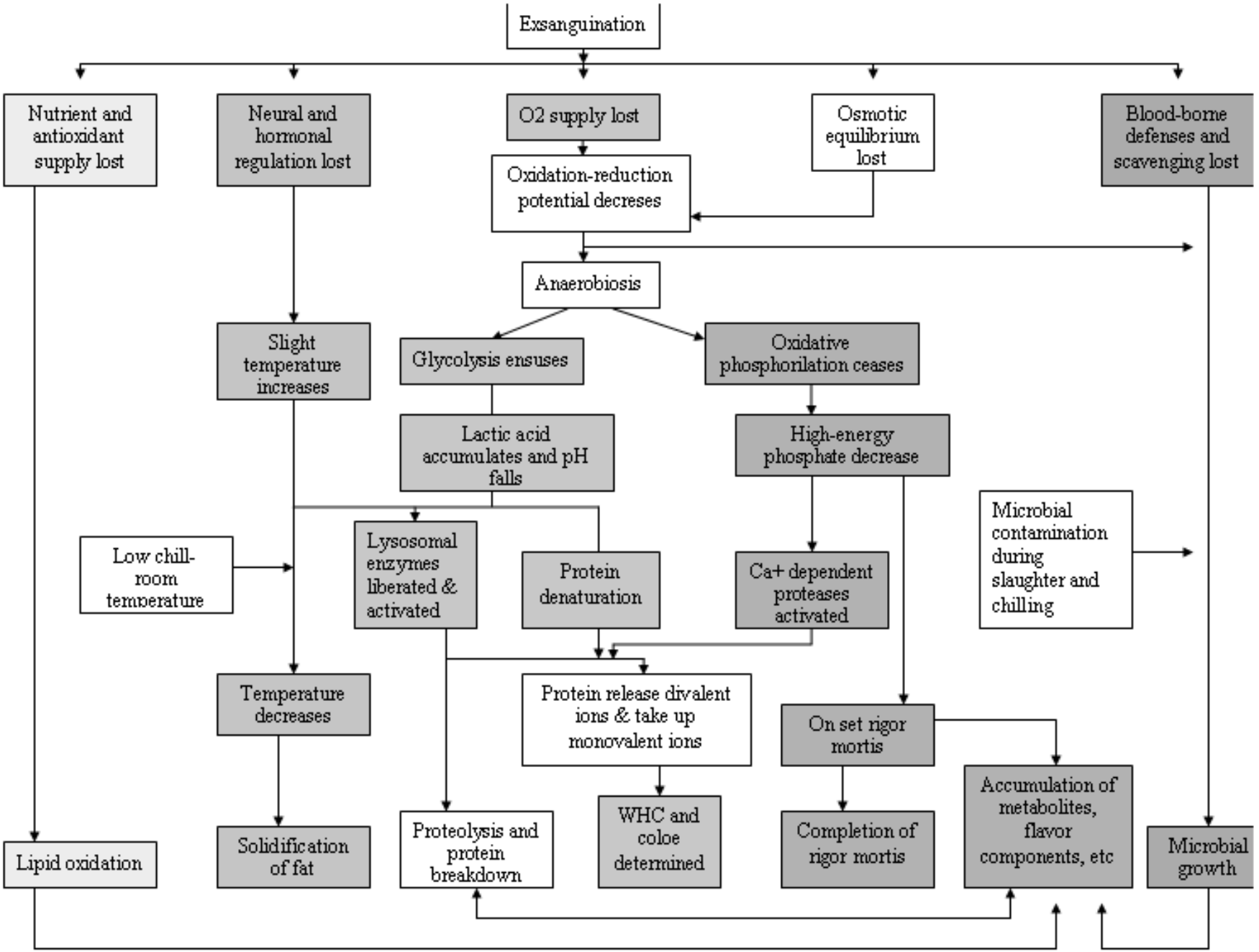
Aberle E D *et al. Principles of Meat Science*. 4th edn. Kendall/Hunt Publishing Co. Dubuque. (2001); Fig 4.8, p 78.

- PSE & DFD Meat



- In stress susceptible animals pH may fall very quickly to pH 5.8 – 5.6 while the carcass is still warm.
- This condition is found most often in pork. It can be recognized in the meat as a pale color, a soft, almost mushy texture and a very wet surface (**pale, soft, exudative = PSE meat**).
- PSE meat has lower binding properties and loses weight (water) rapidly during cooking resulting in a decrease in processing yields.

- A reverse phenomenon may arise in animals which have not been fed for a period before slaughter, or which have been excessively fatigued during transportation and lairage.
- In these cases, most of the muscle glycogen has been used up at point of slaughter and pronounced acidity in the meat cannot occur.
- The muscle pH_{24} does not fall below pH 6.0. This produces **dark, firm, dry (DFD) meat**.
- The high pH cause the muscle proteins to retain most of their bound water, the muscle remain swollen and they absorb most of the light striking the meat surface, giving a dark appearance.


Exsanguination
Nutrient and antioxidant supply lost
Neural and hormonal regulation lost
O2 supply lost
Osmotic equilibrium lost
Blood-borne defenses and scavenging lost
Oxidation-reduction potential decreses
Anaerobiosis
Slight temperature increases
Glycolysis ensuses
Oxidative phosphorilation ceases
Lactic acid accumulates and pH falls
High-energy phosphate decrease
Low chill-room temperature
Lysosomal enzymes liberated & activated
Protein denaturation
Ca+ dependent proteases activated
Microbial contamination during slaughter and chilling
Temperature decreases
Protein release divalent ions & take up monovalent ions
On set rigor mortis
Accumulation of metabolites, flavor components, etc
Lipid oxidation
Solidification of fat
Proteolysis and protein breakdown
WHC and coloe determined
Completion of rigor mortis
Microbial growth

Delay time before on-set rigor mortis

Species	Hours
Beef	6-12
Lamb	6-12
Pork	¼ - 3
Turkey	< 1
Chicken	< ½
Fish	< 1

Ageing

- Holding carcass or meat at refrigeration temperatures for extended periods following initial chilling is called ageing or conditioning.
- During this period, changes occur that alter the properties of the meat, particularly an increase in its tenderness.
- There are large differences between species in ageing rates:
  - Beef: 14 days
  - Pork: 5 days
  - Chicken: 2 days
  - Lamb: between beef and pork

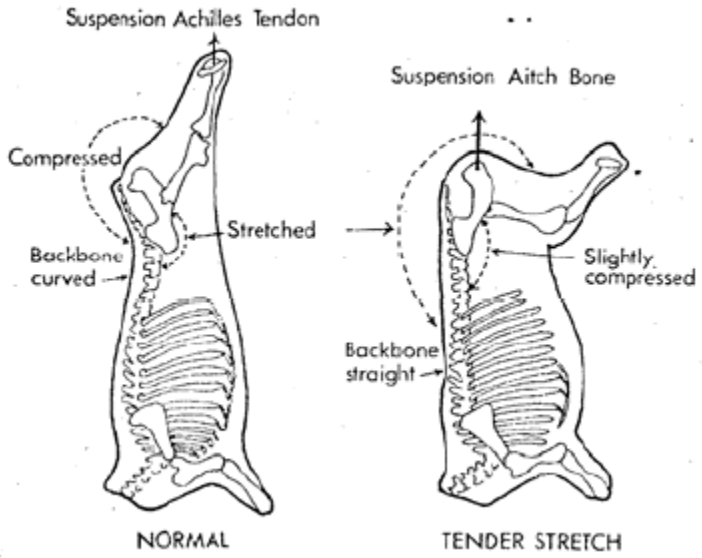
  Differences are due to the differences in rate of proteolysis of the myofibre proteins.

Tenderizing

- Tenderness, juiciness, and flavor are components of meat palatability.
- Tenderness can vary considerably from one cut to another. The differentiation is due to genetics, species, age, feeding, muscle type, slaughtering process (electrical stimulation), chilling rate, ageing, mechanical/ chemical tenderizing, freezing, thawing, and cooking.

Tenderizing Methods

- Tenderstrecth:
  - This method of suspension puts a strain on the muscle fibres and prevents them from shortening to the same extent as normal suspension.



- High temperature conditioning:
  - Chill for 16-20 hours at 12-18^{o}C followed by normal chilled
- Delayed chilling:
  - Hold on slaughter floor (20-25^{o}C) for 3-5 hours before placing in chiller

- Cooler ageing:
  - Hold at 0-10^{o}C for 8-72h allow proteolytic enzyme to degrade fibre
- Blade tenderization
- Application of enzymes: papain, bromelin
- Marinading: vinegar
- Produce fat animal for slaughter: fat insulation

Cooking

- Heating cause a toughening of meat fibres due to heat coagulation and shrinkage of the myofibrillar proteins and connective tissues.
- However, prolonged heating can increase the tenderness due to the conversion of collagen to gelatine by heating.
- The physical changes in meat depend on cooking times, temperature conditions and the amount of collagen in meats.

Cooking

- Initial toughening is due to protein denaturation which occurs when the meat reaches 50-80^{o}C.
- This followed by some tenderisation at temperatures greater than 75^{o}C.
- Tenderisation occurs as collagen hydrolyses to gelatine.

THANK YOU…