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Lecture title: **Meat Hygiene: Meat Structure**

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Summary:

Meat composition varies with species of animal, Species variation due to breed, age, sex, diet, and exercise conditions. Muscle tissue consists of about 75% water and 20% protein. A large part of the remaining 5% is fat with very small amounts of carbohydrate principally glycogen, free amino acids, dipeptides, and nucleotides. Proteins have a very wide range of functions. They may be structural such as the collagen of connective tissues like tendon, contractile such as the actin and myosin that make up a major part of muscle, or enzymes which catalyze chemical reactions e.g., creatine kinase, which catalyses the regeneration of adenosine triphosphate from adenosine diphosphate. They may be hormones and antibodies.

Most proteins are denatured at relatively low temperatures (<60°C) and on exposure to acid conditions. Denaturation leads to loss of solubility in aqueous solutions and loss of enzymic, immunological or hormonal properties. Because proteins constitute such a large part of muscle, denaturation and changes in their solubility and other functional properties have a major effect on the structure and characteristics of meat, affecting its appearance and ability to hold water.

Animal fats is consequently very significant in determining their softness or hardness. Most animal fats are solids at room temperature. Beef fat contains up to 25% stearic acid, which is harder compared to fish which tends to be polyunsaturated, in ruminants. Unsaturated fats in the diet are hydrogenated by the rumen microorganisms to much more saturated fats. This is why the carcass fat of cattle and sheep is hard, despite the fact that the grass they eat contains mainly unsaturated fatty acids. For reasons of human health there is interest in trying to increase the proportion of polyunsaturated fatty acids to saturated fatty acids (the P:S ratio) in meat.

P:S ratio

Lamb 1.1

Beef 0.8

Chicken 0.6

Salmon 0.3

Carcass meat consists of:

- lean
- fat
- bone
- connective tissue.

The fat can be:

- Subcutaneous (lying under the skin of the animal), It is easy to trim to produce leaner-looking meat.
- Inter-muscular (lying between individual muscles) It is more difficult to remove simply.
- Intramuscular (occurring within the body of the muscle). It is also referred to as marbling fat because when abundant it gives a marbled appearance to the lean.

The structure of the muscles is largely defined by sheaths of connective tissue. There are three types of organization. Individual muscle fibers are surrounded by:

- a fine network of connective tissue, the endomysium.
- Bundles of fibers are surrounded by the perimysium
- The whole muscle is contained within the epimysium

The main component of the connective tissue is collagen, together with the protein elastin.

The microscopic structure of the muscle fiber

Fibers hold all the organelles normally found in living cells: nuclei, mitochondria, and an extensive sarcoplasmic reticulum all within the sarcoplasm. The mitochondria contain the enzymes involved in aerobic metabolism. The sarcoplasmic reticulum acts as a store for calcium ions: these are released to start muscle contraction and reabsorbed to stop it. The sarcoplasm also contains lysosomes, which act as a reservoir of various proteolytic enzymes, and granules of glycogen. In a single fibre there might be between one and two thousand fibrils each about 1 μm in diameter Each fibril is itself made up of smaller elements called filaments. These are of two sorts, thick filaments (about 15 nm in diameter) consisting mainly of the protein myosin and thin filaments (about 7 nm in diameter) consisting mainly of the protein actin. Under certain conditions actin and myosin can react together to produce contraction of the muscle.Thin, short fibers will give us meat that is mostly tender to eat, and thick, long fibers will give us meat that is mostly tough to eat. The individual myofibrils also have alternating stripes, and the striations in the fiber occur because the adjacent myofibrils have their respective light and dark bands aligned. The dark bands are called the A-bands and the light bands the I-bands. A thin perpendicular line referred to as the Z line bisects the I-bands. The region between successive Z lines is called a sarcomere and it is the smallest functional.

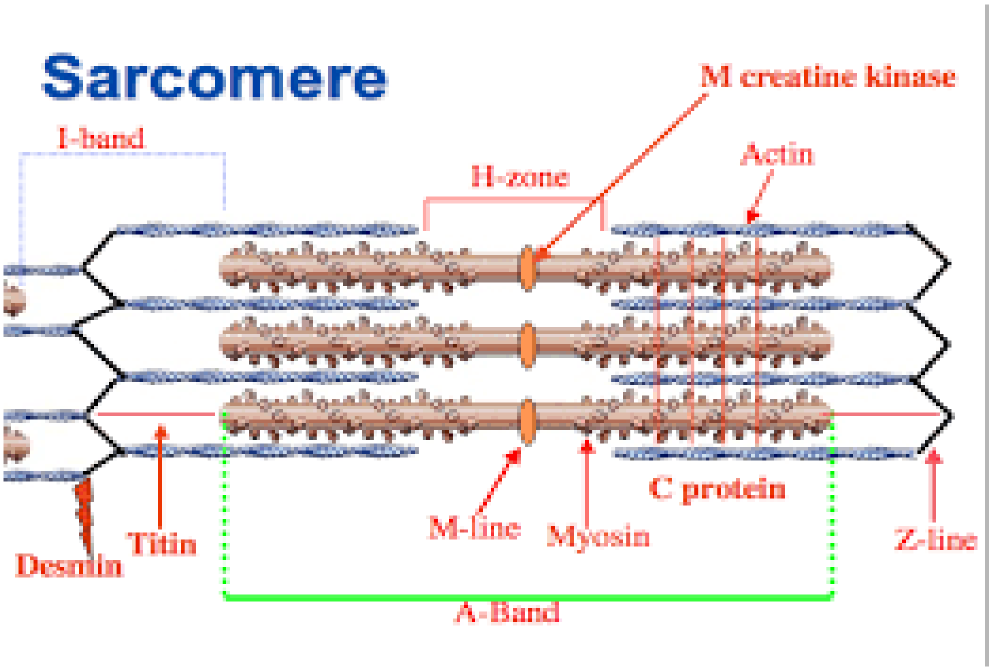

Figure 1: The banding pattern of the muscle fibril and Arrangement of the thick and thin filaments.

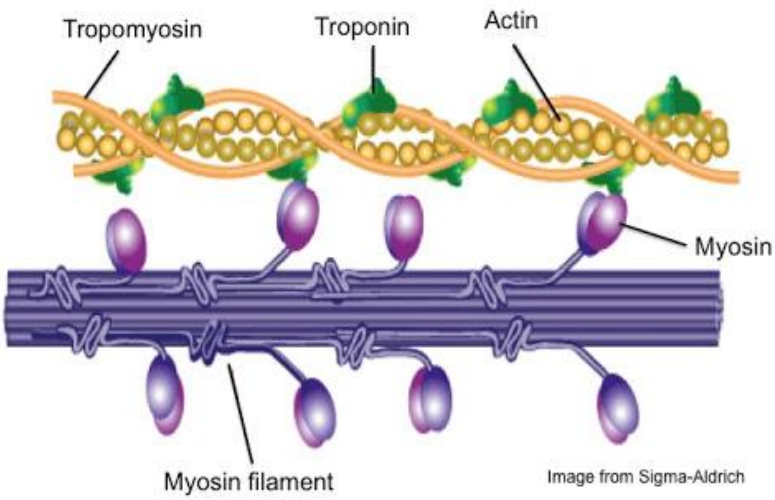

Figure 2: The arrangement of actin, tropomyosin and troponin in the thin filament.

They are linked by the cross-bridges formed by the heads of the myosin molecules. Muscles normally contract in response to a nervous stimulation. This causes acetylcholine to be released by the neuromuscular junction. The acetylcholine produces a local depolarization of the muscle fibre membrane resulting in K+ ions move out the cell and Na+ ions move in. Normally, the sarcoplasmic reticulum maintains the concentration of calcium ions (Ca2+) in the sarcoplasm very low (less than 0.1 µM) Depolarization causes a very large release of Ca2+ from the sarcoplasmic reticulum back into the sarcoplasm. , increase in Ca2+ (to about 10 µM) removes the normal inhibition exerted by tropomyosin and troponin on the attraction between myosin and actin and so causes a contraction.

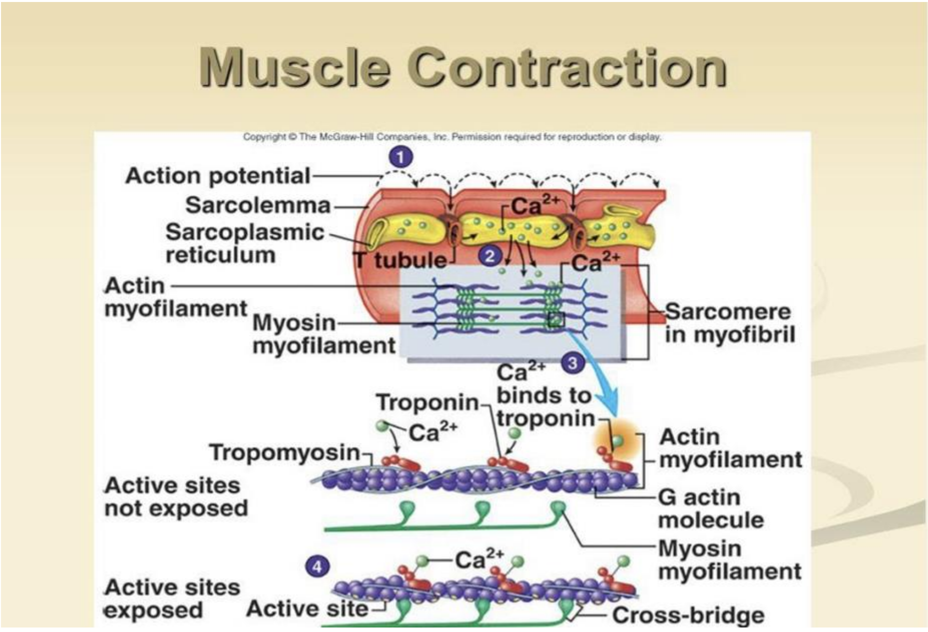

Figure 3: mechanism of muscle contraction

The pH has a very strong influence on the muscle:

1. texture
2. tenderness
3. color
4. water-holding capacity.