

Structure of skeletal muscle of fish

There are three types of muscles: (i) striated muscles (ii) smooth muscles and (iii) the heart muscle.

Striated muscles constitute the livestock meat or fish meat. Smooth muscles constitute viscera and the tissue of mollusks. The heart muscle is an intermediate structure between the other two.

Livestock meat and fish meat are basically striated muscles which are formed by groups of muscle fibers with striations.

Individual skeletal muscles vary greatly in size and morphology. They consist of a parallel arrangement of elongated, multinucleated cells called myofibrils or muscle fibers.

Color of fish meat

Fish muscle can be divided into two groups according to color:

ordinary muscle (white meat).

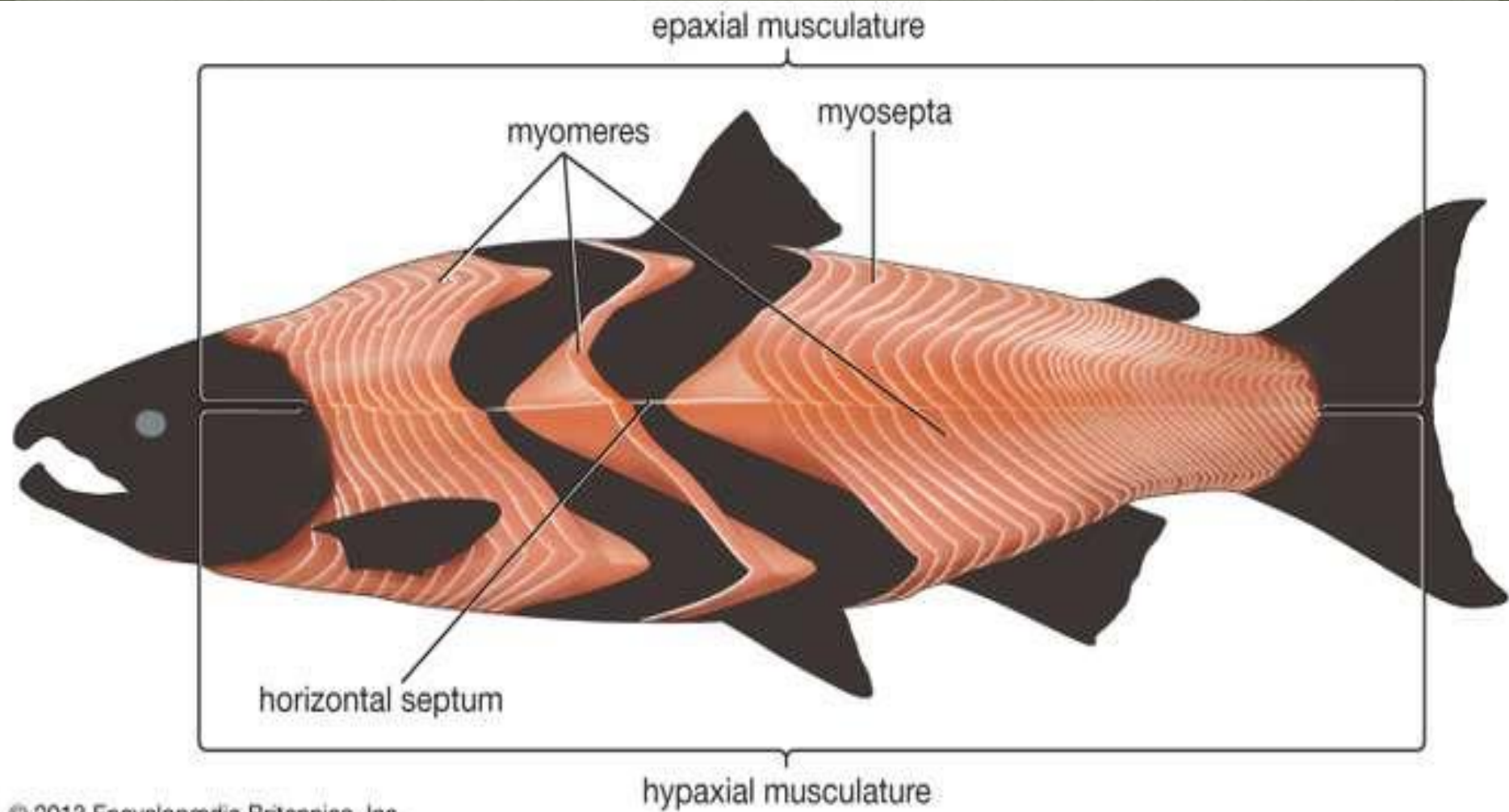
dark muscle (red meat) .

White meat forms the major portion of fish muscle and the dark muscle lies along the sides of the body under the skin and near the vertebrae

.The shape and volume of red muscle vary according to the fish species.

Proximate composition of dark and white meat of some fishes

Fish species	Kind of meat	Moisture %	Crude protein %	Crude fat %
Tuna	D	66.4	22.9	6.7
	W	68.5	22.9	4.5
Sardine	D	70.0	15.9	12.8
	W	72.0	23.1	2.9
Mackerel	D	54.2	14.9	29.7
	W	65.5	21.2	13.1
Herring	D	57.8	15.5	28.2
	W	74.0	22.0	13.0
Cod	D	77.8	18.6	2.5
	W	78.4	19.9	0.5
Halibut	D	62.0	11.3	27.3
	W	77.7	14.5	7.0

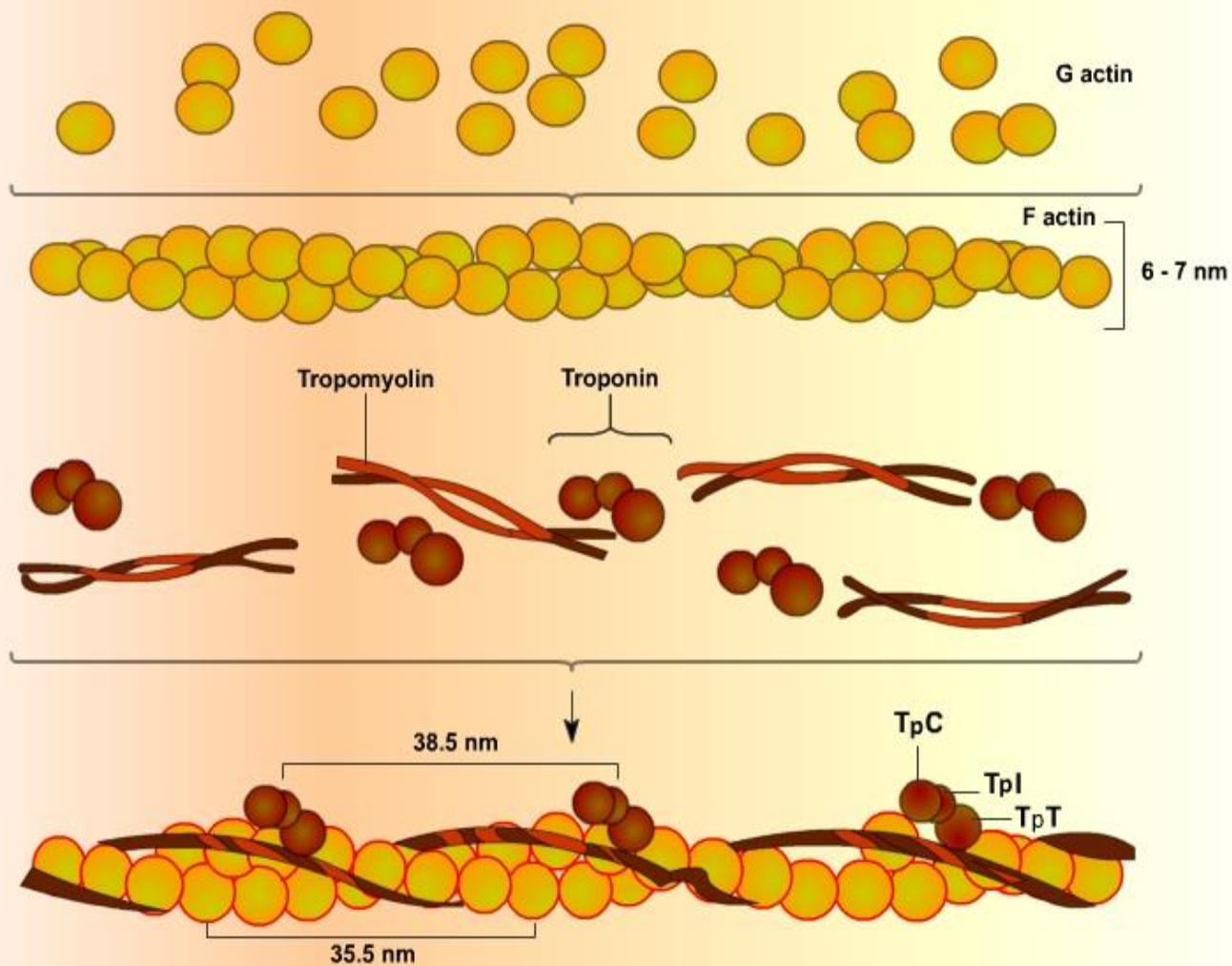


Sarcoplasmic protein contains many kinds of proteins called myogen (myoglobin, globulin and enzymes) constituting 21-25% of the total protein. These proteins are soluble in neutral salt solutions of low ionic strength. The content of sarcoplasmic protein in fish meat varies with fish species, but generally higher in pelagic fish such as sardine and mackerel, and lower in demersal fish like snapper and plaice. It is disposed off during the water washing and pre-processing of fish. The protein of this fraction is suited to distinguish between different fish species as all the different species have their characteristic band pattern when separated by the isoelectric focusing method.

Myofibrillar protein forms myofibril, which contains myosin, actin, tropomyosin, troponin and actinin. These proteins cover 66-76% of the total protein of the fish meat. These proteins are soluble in neutral salt solutions of high ionic strength ($<0.5M$). They make up the contractile apparatus responsible for muscle movement. The structure of fish protein is easily changed by changing the physical environment. The solubility characteristics are greatly affected freezing frozen storage. Treatment with high salt solution denatures proteins and the native structure is irreversibly altered. These proteins play an important role in coagulation and gel forming when fish meat is being processed. Fish meat contains a larger percentage of myofibril protein than mammalian skeletal muscle. The amino acid composition of fish muscle is approximately the same as that of the protein of mammalian muscle.

Stroma protein is the protein, which forms connective tissue. It is made up of collagen and elastin. It constituted approximately 3% of the protein of teleost fishes and about 10% of the elasmobranches. It cannot be extracted by water, acid or alkaline solution and neutral salt solution of 0.01-0.1M concentration. Fish meat separates easily from the myomere when heated. This phenomenon is caused by gelatinization of collagen in thin myocommata which combines the myomere. Elastin is very resistant to moist heat and cooking does not affect elastin in connective tissue. Lately the existence of elastic fibers in the cell has been discovered. Dark meat contains more stroma protein than white meat, but less sarcoplasmic protein. White meat contains more connectin while the connectin of dark meat is half that of white meat.

Arrangement of thin filament



Proximate composition of seafood

Type of fish	Moisture %	Protein %	Fat %	Ash %	Carbohydrate %
Fatty fish	68.8	20.0	10.0	1.2	Negligible
Lean fish	81.8	16.4	0.5	1.3	< 0.5
Crustaceans	76.0	18.8	2.1	3.1	< 0.5
Mollusks	81.0	12.0	1.5	2.6	2.9

Variation of lipid content of dark and white meat of some fishes

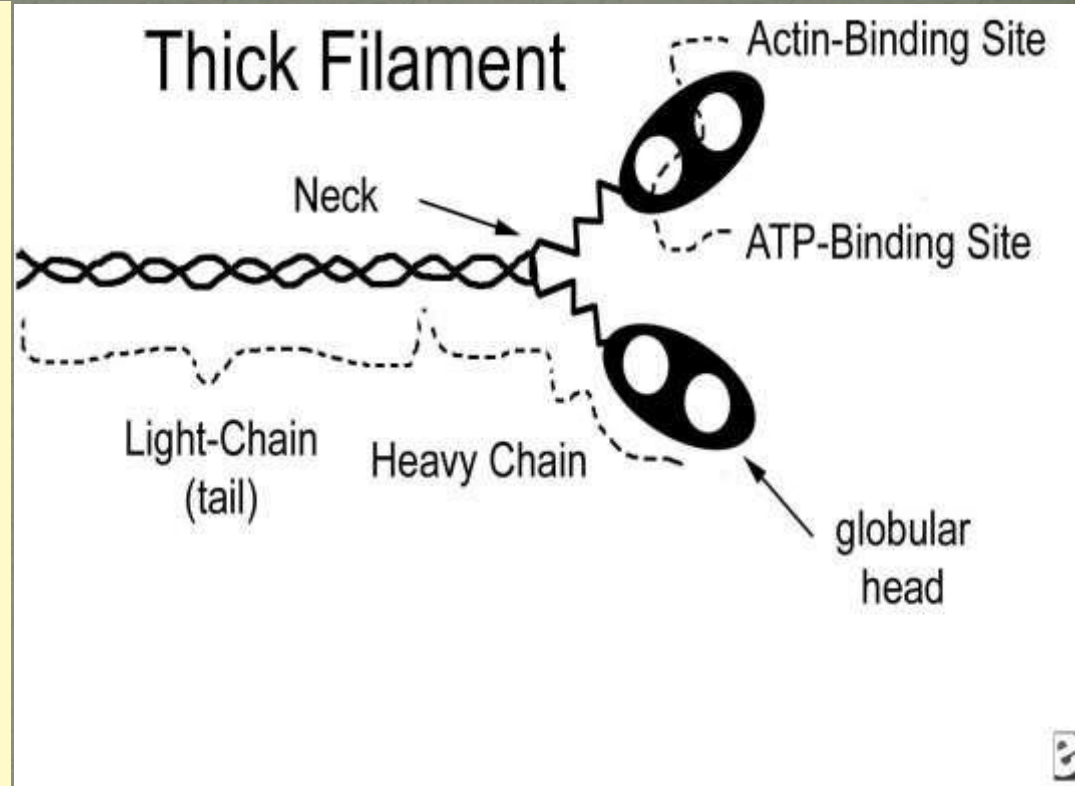
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1) Myofibrillar Protein

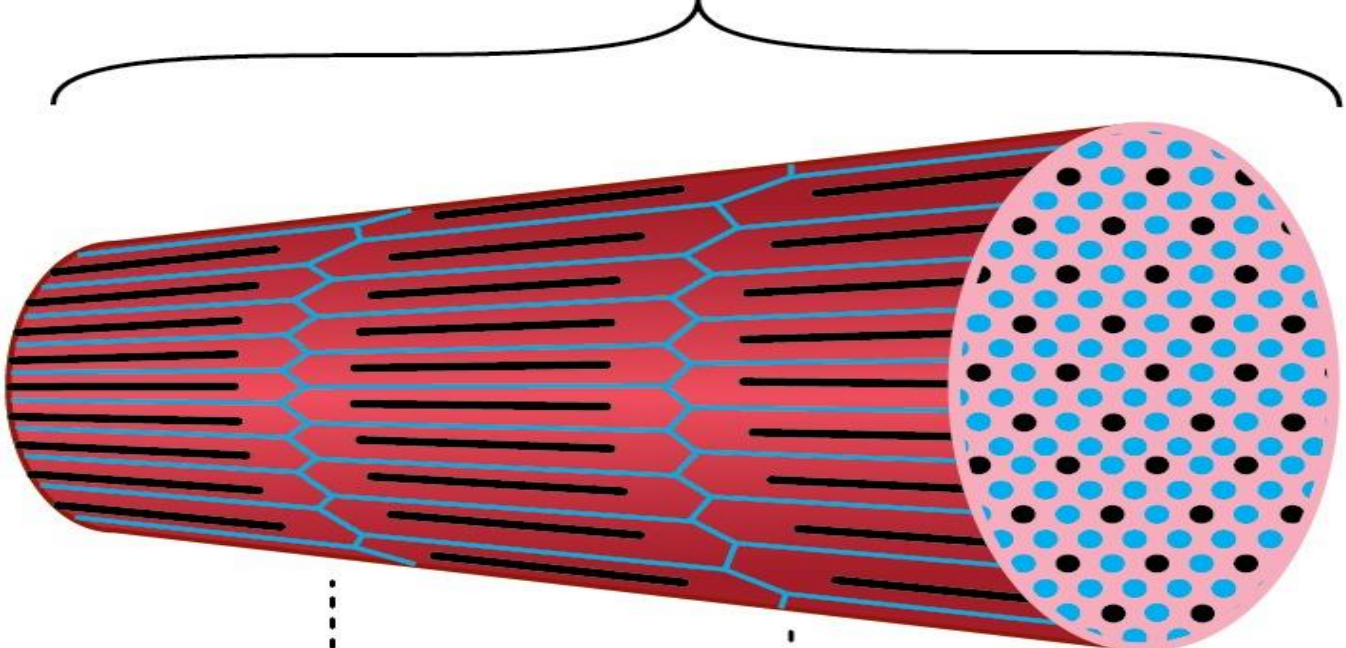
- Myofibrillar is the protein that forms myofibril, which contains **Myosin, Actin, Tropomyosin, Troponin and Actinin.**
- Myofibrillar protein covers 66-77% of the total protein in fish meat.
- These proteins are soluble in natural salt solution
- This protein is responsible for coagulation and gel formation during different processing methods.

Myosin

- Myosin is the protein which forms the **thick filaments** .
- A molecular weight is about **500,000** daltons.
- It is most abundant myofibrillar component, constituting approximately 40-60% of total protein content.



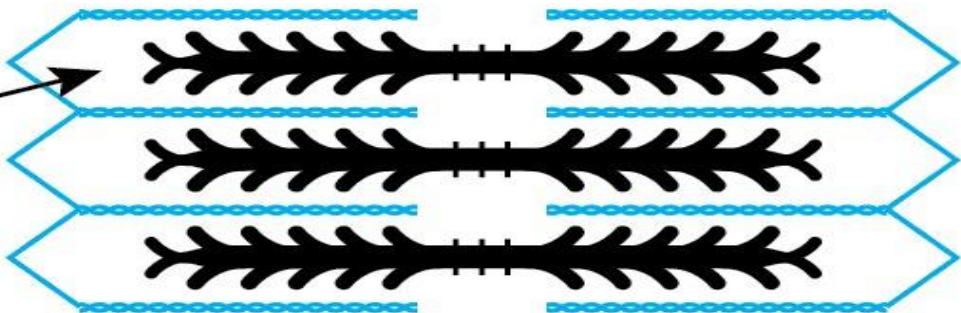
MYOFIBRIL



SARCOMERE

ACTIN

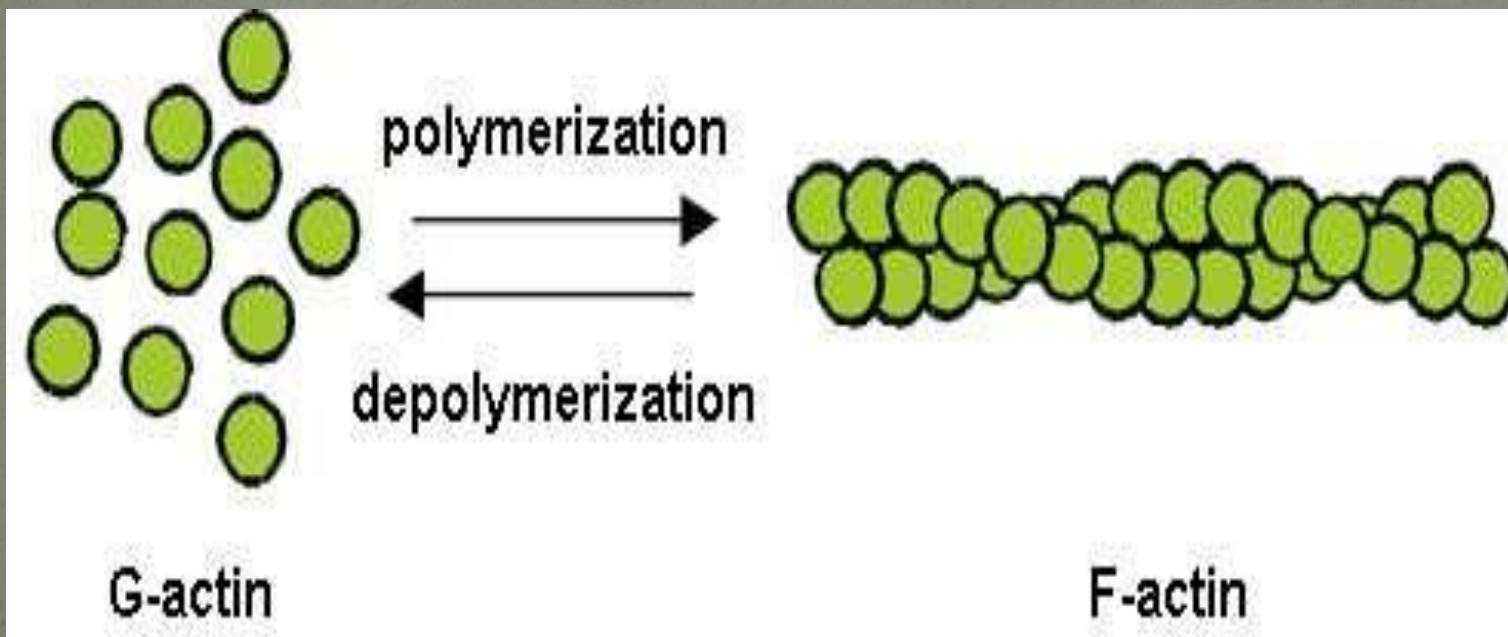
MYOSIN



Actin

- It constitutes about 22% of the total myofibrillar protein.
- It can be present as either a free monomer called G-actin (globular) or as part of a linear polymer microfilament called F-actin(filamentous), both of which are essential for such important cellular functions as the mobility and contraction of cells during cell division.

➤ Monomer form of actin i.e. G-actin and after polymerization, actin filaments are formed and called F- actin.



2) Sarcoplasmic protein-

- Sarcoplasmic protein contains many kinds of water soluble proteins (myoalbumin, globulin and enzymes) called **myogen**.
- These proteins are soluble in neutral salt solution of low ionic strength (0.15M).
- It covers a accounts for 25-30% of the total proteins.
- The concentration of sarcoplasmic protein is high in pelagic fishes such as sardine, mackral while lower in demersal species.
- The electrophoretic pattern of sarcoplasmic fraction can be used for species identification.

3)Stroma Protein-

- Stroma proteins accounts for about **3% of total proteins in teleosts** and **10% in elamobraches**.
- These are connective tissues and insoluble in neutral salt solution or in dilute acids or alkalies.
- The component of stroma is collagen, elastin or both.
- Elastin is very resistant to moist heat and cooking.
- Collagen is almost totally insoluble in water or saline and does not participate in gel formation
- Collagen is present in skin, air bladder of the fish and it convert in gelatin during heat processing.