ur website www.jaypeebrothers.com, for detailed information on veterinary books, visit our website www.jaypeebrothers.com

Modern Abattoir Practices & Animal Byproducts Technology





BD Sharma

2nd Edition

JAYPEE

Contents

1. **Meat Animals 1**
   - Goat 2
   - Sheep 3
   - Pig 5
   - Buffalo 6
   - Cattle 7
   - Judging and Grading of Live Meat Animals 7
   - Some Other Meat Species 9

2. **Organization, Layout and Management of Slaughter Houses.....11**
   - Planning 11
   - Abattoir Design and Consideration 13
   - Management Systems 21

3. **Preslaughter Care, Handling and Transport of Meat Animals 26**
   - Transport of Meat Animals 26
   - Effect of Transport on Meat Animals 28
   - Preslaughter Handling and Care of Animals 29

4. **Antemortem Examination of Meat Animals.....30**
   - Objectives 30
   - Examination Procedure 31
   - Principles of Judgement 31

5. **Slaughtering and Dressing of Meat Animals.....35**
   - Scientific or Humane Slaughter 35
   - Dressing Techniques for Different Animals 40

6. **Postmortem Inspection of Meat Carcasses 44**
   - Objectives 44
   - General Principles 45
   - General Regulations for Judgement 46

7. Evaluation of Dressed Carcasses 63
- Evaluation of Goat and Sheep Carcasses 64
- Evaluation of Buffalo Carcasses 66
- Evaluation of Swine Carcasses 68

8. Chilling and Aging of Dressed Carcasses.....71
- Chilling of Dressed Carcasses 71
- Aging of Dressed Carcasses 73

9. Disposal of Carcasses and Condemned Parts of Animals Died due to Notifiable Diseases.....75
- Disposal of Carcasses 76
- Isolation of Carcasses and Related Materials on the Spot 76
- Veterinary Advice 76
- Transportation 76
- Methods of Disposal of Carcasses 77
- Disinfection 78

10. Maintenance of Slaughter Houses and their Sanitation 79
- Building 79
- Agents Used in Sanitation 80
- Organization of Cleaning Schedule 83
- Personal Hygiene 84

11. Abattoir Effluent Treatment.....85
- General Principles of Treatment 85
- Effluent Treatment Steps 87

12. Meat Eating and Animal Welfare 89
- The Prevention of Cruelty to Animals Act, 1960 90
- Animal Welfare Board 90
- Tips for Good Animal Welfare 91

13. Scope for Utilization of Animal Byproducts 93
- Classification of Animal Byproducts 95
- Advantages of Byproducts Utilization 96

14. Plan and Layout of Byproducts Utilization Plant.....99
- Transportation of Dead or Fallen Animals 100
- Production of Stock Feed by Carcass Utilization Plant 102
- Yield and Conversion Ratio 105
- Carcass Utilization Plant (Sequence of Operations) 106
- Typical Operations of a Dry Rendering Unit 107

- Composition/Nutrients of Various Stock Feeds 108
- Mobile and Makeshift Carcass Processing Units 108

15. Utilization of Blood 109
- Average Yield of Blood/Animal 109
- Blood Products 110
- Uses of Blood 110

16. Utilization of Intestines.....115
- Intestine as a Raw Material for Casings 116
- Steps in the Preparation of Animal Casings 120
- Defects in Animal Casings 121
- Grading of Animal Casings 122

17. Utilization of Bones 124
- Gelatine and Glue 124
- Bone Meal 127
- Bone Ash or Calcined Bones 128
- Utilization of Hoofs (Shin Bones) 129
- Utilization of Horns 129

18. Glandular Byproducts 131
- Guidelines for Collecting Glands 131
- Important Glands and their Biochemicals 132
- Preparation of Insulin from Pancreas 135
- Preparation of Heparin from Cattle Lungs 136
- Preparation of Liver Extract 137

19. Optimal Harvesting of Hides and Skins 138
- Classification and Nomenclature of Hides and Skins 140
- Flaying 141
- Preservation of Hide and Skins 144
- Tanning 148

20. Wool (Basics) 150
- Quality Characteristics 151
- Post Harvest Handling 153
- Quality Control of Carpet Wool 154

21. Bristles.....158
- Characteristics 158
- Post Harvest Handling 159
- Quality Control of Bristles 160

22. Utilization of Organic Waste Available through Animal Industry 165
- Production of Biogas for Light and Heat 165
- Production of Compost Manure 166

23. Utilization of Animal Byproducts in Pet Foods 168
- Classification of Pet Foods 169
- Flowchart for the Preparation of Dry Pet Food 170
- Byproducts as Raw Material in Pet Foods 172

24. Wool Technology 176
- Status of Wool Production and Trade 176
- Wool Terminology 178
- Morphological Structure of Wool Fiber 182
- Physical Properties of Wool 187
- Chemical Properties of Wool 189
- Defects/Faults in Wool 191
- Quality Evaluation of Wool 192
- Grading of Wool 193
- Processing of Wool 195
- Specialty Fibers 201

Index 205

24

CHAPTER

Wool Technology

Fibers are very important to the mankind. As clothing, these make up one of the three basic needs of human beings. Natural fibers contribute about 50% of the entire fiber basket and mainly comprise of cotton and animal fibers. Traditionally, the fibers covering the skin of sheep are called wool. The wool has a predominant position in the animal fibers because of its unique characteristics. Indian sheep breeds, spread over a wide range of environmental conditions, produce wool which differ in fineness from 25 to 60 micron in diameter. Specilty fibers refer to similar fleece such as mohair (Angora goat), Pashmina (Cashmere goat), Angora wool (Angora rabbit hair), camel hair, Llama hair, Alpaca hair, Yak fiber, etc. In general, undercoat of mammals other than sheep, goat or camel families are referred as fur. These animal fibers have inherent qualitative differences which are species and breed specific.

The principal end-use of animal fibers especially wool is in suiting and knitted garments for men whereas for women, the important end-use is the production of shawl, coating and dress materials, etc. In addition, nonapparel wool is mainly utilized for the production of hand knotted, tufted and woven carpets.

STATUS OF WOOL PRODUCTION AND TRADE

India has the third largest sheep population in the world with 74 million sheep, producing 45 million Kg of raw wool per year whereas consumption is about 260 million Kg. Production of raw wool has remained almost constant in the last over one decade with minor annual variations. The country can be divided into four agro-climatic regions with reference to wool production:

1. North Temperate Region
2. North Western Arid Region
3. South Peninsular Region
4. Eastern Region

JAYPEE BROTHERS

Sheep population is most and about equally spread in North Western region of the country in the states of Rajasthan, Gujarat, Punjab, Haryana and South Peninsular region consisting of Karnataka, Andhra Pradesh, Tamilnadu and Maharastra. The wool produced in North Western region is higher and finer than Southern Peninsular region. The average wool productivity of Indian wool is 800 grams/sheep per year.

Indian wool industry is seventh largest in the world and it accounts for about 2% of the total global wool production. Due to anadequate domestic production, industry is dependent on imported raw material. In fact, wool is the only natural fiber which is deficient in India. With about 35% production of wool, Rajasthan leads all the states in India, followed by Jammu and Kashmir (15%), Karnataka (12%) while Telangana, Gujarat, Uttar Pradesh and Haryana produce about 25% wool. Some quantity of Pashmina and Angora rabbit hair is also produced. Maximum amount of wool produced in India, about 85% is of carpet grade and only 5% is of apparel grade. Rest about 10% of the entire production is of coarse grade wool.

India does not produce quality raw wool in sufficient quantity and has to import large quantity of fine wool mainly from Australia and New Zealand. However, India is an important exporter of woolen goods especially woolen fabrics, hosiery and knitwear, shawls, lohis, blankets and carpets. There are about 720 woolen units in the organized sector and a large number of units in small scale sector. Ludhiana alone accounts for nearly 220 units in decentralized hosiery as well as shawl sector and this industry is largely dependent on imported wool. Worsted industry is located at Bombay, Jamnagar, Amritsar, Baroda and Bhilwara. It utilizes imported Australian wool of 64s quality for the production of apparel from wool and ita blends with polyester.

Carpet yarn is produced in woollen system and by hand spinning. Indian carpet industry directly employs about 2 million and indirectly about 3.5 million workers. The major carpet yarn production centers are Bikaner, Panipat, Bhilwara, Beawer and Bhadohi. Most of the yarn produced at different centers is sent in the scoured stage is sent to Bhadohi, where it is dyed in desired shades. Hand-knitted carpets are mainly produced at Bhadohi-Mirzapur and Jaipur-Agra-Gwalior contributing to 80% carpet production in India. The other centers in this segments being Jammu and Kashmir for superfine and Warangal-Eleru for low medium types of carpets.

JAYPEE BROTHERS

Global production of wool is about 2 million tons per year. Australia is the leading producer of wool which is mostly from Merino sheep used by apparel sector. New Zealand is the second largest producer, mostly of crossbred medium wool. China is the third largest producer, mostly of carpet wool. The important wool exporting countries are Australia, New Zealand, South Africa, Argentina and Uruguay. Australian share in total world wool trade is more than 45% and most of it is raw wool. New Zealand is the second largest exporter of raw wool, accounting for about 20% of the total wool exported over the world. The major importers of raw wool from Australia and New Zealand are China, Japan, India, Russia, U.S.A., Germany, U.K., Italy, France, etc.

India is an important exporter of woolen goods especially woolen fabrics, hosiery and knitwear, shawls, blankets and carpets. India exports these items to almost 150 countries notably U.S.A., Russia, U.K., Canada, Germany, Denmark, Sweden, France, Belgium, etc. U.S.A. and E.U. countries are the key importers of Indian woolen and wool blended items. Indian handmade carpets are renowned world over due to their exquisite designs, attractive colors and workmanship. Woolen handmade carpets contribute to about 74% of our total wool exports. These are exported to over 100 countries. U.S.A. is the largest importer of Indian carpets.

Indian export of woolen goods amounted to 6,900 million dollars in 2020–2021. We have to further strengthen the export production of woolen goods by modernization of machinery and utilization of large pool of skilled as well as comparatively cheaper work force. The garment manufacturing activities should also get a boost for expansion in the organized sector. The industry has further potential to generate lot of employment.

Wool Terminology

Wool: It is a textile fiber of animal origin which is crimped, elastic, noninflammable and nonliable to melt.
Shearing/Clipping: The process of removal of wool by hand or scissors or machine.
Fleece: It is the fiber/coat that covers a sheep body. Fleece also refers to the total wool obtained in one shearing
Burr: It refers to the vegetable matters like twigs, straws, etc., present in the wool.

JAYPEE BROTHERS

Lock: A group of fibers clinging together in fleece is called a lock.
Greasy wool: It is the wool as shorn with grease and wax, etc., before the impurities are removed.
Bale: It is a pack of wool containing a specified minimum weight.
Kemp: A coarse and brittle wool fiber having greater medullation. It is chalky white in appearance.
Skirting: It refers to the wool obtained from lower portion and leg portions of the fleece which is dirty and stained.
Keratin: Wool protein is specifically called as keratin.
Crimp: It is the natural waviness of a wool fiber. It is more in finer wool fibers.
Scales: These are flattened cuticle cells that protect the cortex of animal fibers.
Suint: It is a dried secretion of sebaceous or sweat glands of the skin of sheep. In simple language, it is the dried sweat of sheep. It is water soluble material of raw wool. It is alkaline in nature with potassium salts.
Wool grease: It is fatty pale yellow wax that coats the fibers of the sheep wool and yields lanolin. It is secreted by the sudoriferous glands of the skin of the sheep.
Wool yolk: It refers to the combined secretion of the sudoriferous and sebaceous glands of the skin of sheep. It includes both wool grease and suint. Wool yolk is more in finer wool and increases in winter.
Lanolin: It is purified form of wool wax, which can be used in emollients as well as cosmetics.
Cortex: It is the main shaft of the wool fiber lying beneath a layer of cuticular scales surrounding medulla.
Medulla: The hollow rounded cells which are found along the center of the main axis of a fiber.
Pelt: It refers to skin of the animal with hair/wool/fur still attached to it and due for removal before tanning.
Felt: Sheet of wool fibers matted into thick or bulky textile material is called felt and this irreversible process is called felting.
Sorting: It is the separation of fleece or fiber or staple into groups of comparable character and quality.
Yarn: It is a continuous length of interlocular fibers, suitable for the production of textile. Thread is a type of yarn intended for sewing by hand or machine.
Weaving: It refers to the process of interlacing yarns at right angles.
Carbonization: It is the chemical treatment of wool for removal of vegetable matter or burr.

JAYPEE BROTHERS

Scouring: It is the washing treatment of raw wool with detergent usually sodium carbonate by removal of impurities like dirt, grease, foreign matter, etc., in order to obtain clean wool.
Card: It is a roller type machine with teeth to separate wool by opening locks.
Carding: It is a process in yarn manufacture in which fibers are brushed up and made more or less parallel, considerable foreign matter get removed and fibers are put in manageable rope form known as sliver.
Sliver: A strand of loose, untwisted fiber produced in carding.
Combing: It is done after carding in worsted spinning. This process retains long desirable fibers and lays them parallel to form sliver called 'top' while removing naps and short fibers(noils).
Hank: It is a definite length of yarn or thread as a measurement of quality of wool in worsted system.
Fellmongering: It refers to the process of removal wool fiber from sheep skin through the use of chemical application(sodium sulfite, etc.) or injection for partial moulting.
Sweating: It is the process of removal of wool by bacterial digestion of peri keratinous region of sheep skin.
Tweed: It refers to a durable fabric with rough apperance, soft and pliable yet firm in weave.
Roving: It is a long and narrow bundle of wool fibers with a twist to hold the fibers together.
Cotty wool: It is the wool that has been matted or felted on sheep body due to insufficient amount of grease or wax.
Gare: Low grade fiber from the legs of wool.

General Characteristics of Wool

1. Wool is hygroscopic in nature and its core or interiors can absorb moisture in vapor form to the extent of about 30% of its weight without feeling wet. However, wool surface repels water.
2. Wool is an excellent insulator. It prevents body heat from escaping and cold from entering.
3. Wool is renowned for heat of wetting, which refers to its ability to evolve or give off some amount of heat while absorbing moisture.
4. Wool is elastic and resilient, which allows it to stretch and return to its original shape.
5. Wool is soft and light, yet strong and durable.

JAYPEE BROTHERS

6. Wool can easily and permanently absorb many different dyes (**Table 24.1**).
7. Wool is naturally resistant to flames.

Table 24.1: Differentiating features between wool and hair.

Parameter	*Wool*	*Hair*
Diameter	Less	More
Cuticle	Irregular	Regular and smooth
Medulla	Very less or absent	Pronounced
Softness	More	Less
Elasticity	More	Less
Heat retention	More	Less
Moisture retention	More (12–17%)	Less (7–12%)
Dye retention	Permanent	Temporary

Components of raw wool fiber.	
Keratin	33%
Grease	28%
Suint	12%
Diff. impurities	26%
Mineral matter	1%

Development and Growth of Wool

Wool fibers and hair develop from the structures in the skin called follicles. Each follicle contains a long root tube which is a downgrowth from the epidermis into the inner dermis. There are two types of follicles—primary and secondary follicles. Primary follicles develop in the growing fetus from about 45 days and become constant at 90 days of pregnancy. Then, secondary follicles start developing at about 90 days of pregnancy till the birth of lamb and sometimes even one or 2 months after the birth of lamb. Various features of these follicles are as follows:

Primary Follicle

(a) Responsible for the production of hair, kemp and very coarse wool.

JAYPEE BROTHERS

(b) These have an erector muscle (*Arrector pili*), which enables the hair to stand and a sebaceous gland to grease the fleece. Sweat gland is also present.
(c) The follicles are comparatively larger in diameter, less in number and arranged as trio (group of three).

Secondary Follicle

(a) Responsible for the production of true wool fiber.
(b) Sebaceous gland is smaller while erector muscle and sweat gland are absent.
(c) These follicles are comparatively smaller in diameter, often branched, many in number and lie to one side of primary follicles.

Proportion of secondary follicles to primary follicles (S/P ratio) determines the fineness of wool. The S/P ratio in Merino sheep breed is 15–25:1, whereas it is 2:1 in Indian coarse wool sheep breeds.

MORPHOLOGICAL STRUCTURE OF WOOL FIBER

Wool is an animal fiber forming protective covering of animals like sheep (**Figs. 24.1–24.3**). It consists mainly of insoluble protein like keratin. There are three morphological components of animal fiber:

1. Cuticle
2. Cortex
3. Medulla

Cuticle

Cuticle is the outer most layer of the fiber. It is composed of flat plate-like cells called scales, which overlap each other with exposed edges pointing towards the fiber tip. Cuticle scales make up about 10% of the mass of whole fiber and their patterns contribute to the surface properties like smoothness and luster of the fiber. Felting property of wool also depends on the interlacing of scales. The scale pattern could be:

(a) *Coronal pattern*—Each scale forms a complete ring around the bottom of the next scale. True coronal scale pattern is seen in very fine wool fiber like merino.
(b) *Reticulate pattern*—The scales form an irregular network over the surface of fiber. This pattern is found in coarse wool.

JAYPEE BROTHERS

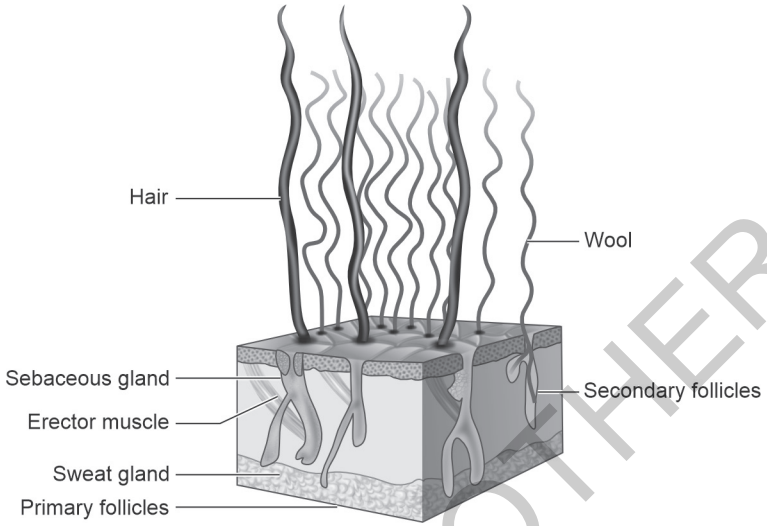

Fig. 24.1: Schematic arrangement of follicles in sheep skin.

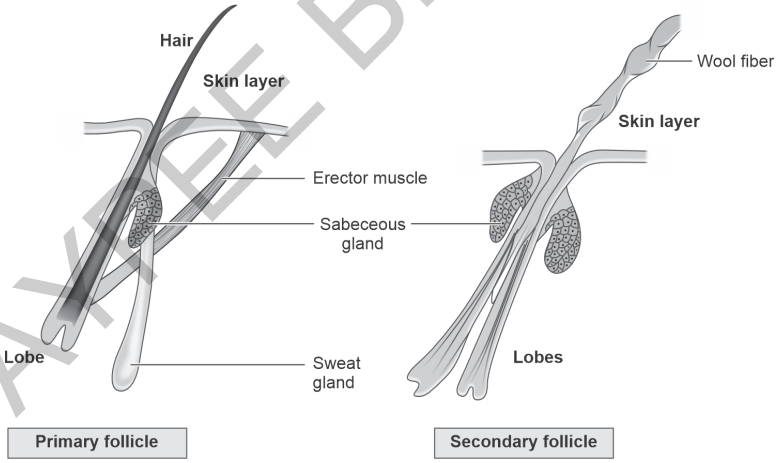

Fig. 24.2: Wool follicles.

JAYPEE BROTHERS

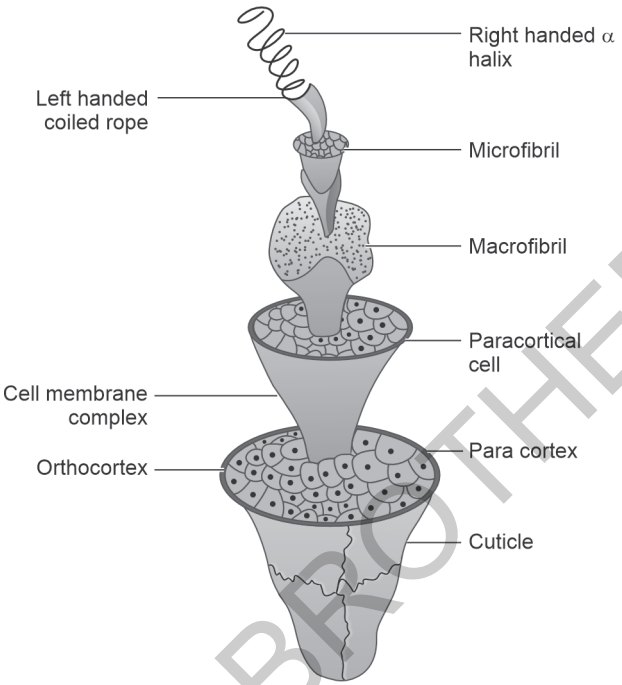

Fig. 24.3: Schematic diagram of wood fiber.

(c) *Coronal reticulate*—It is a mix of both patterns and seen in coarse merino wool and some kemp fibers.

Cuticle is not a homogenous structure and can be subdivided into three regions:

1. Epicuticle
2. Exo-cuticle
3. Endo-cuticle

(i) *Epicuticle:* It is a thin continuous membrane of about 3μm thick that surrounds the individual cuticle cells. It is generally associated with the nature of the fiber surface due to strongly bound lipid substances, which can be removed by the alkali treatment (**Fig. 24.4**).

(ii) *Exo-cuticle:* It is a keratinous layer immediately below the epicuticle. It is about 0.3 μm thick in merino wool and make up about 60% of the total cuticle cells. The major part of cystine of the cuticle is here, which makes it resistance to digestion of enzyme.

JAYPEE BROTHERS



Cuticle

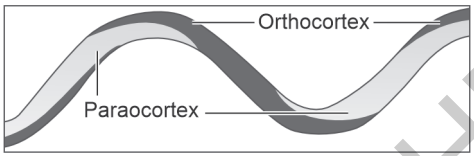

Fig. 24.4: Cuticle and cortex arrangement.

(iii) *Endo-cuticle:* It is a well defined layer below exo-cuticle with which it is cemented by cell membrane complex. It is around 0.2 μm thick and make up about 40% of the total cuticle cells. It is mechanically as well as chemically weak region of the cuticle.

Cortex

Cortex is the major portion (80%) of the wool fiber and is located on the inner side of cuticle. It is responsible for most of the chemical reactions and several mechanical properties of the fiber. The cortex of the fine wool consists of overlapping spindle shaped cortical cells, arranged parallel to the fiber axis. Each cell is surrounded by a cell membrane complex in a continuous phase. The cortical cells make up microfibrills which are packed together in bundles called *macrofibrils*. The cortical cells are held togather by cementing cell membrane complex. The microfibrils split further into smaller units (**Fig. 24.5**).

There are two major components of cortex-orthocortex and paracortex, which show bilateral differentiation responsible for crimped appearance of fine wool fiber. This bilateral segmentation is less distinct in coarse wool fiber. The two components of cortex differ in chemical reactions including dye receptivity and swelling in alkali. Ortho cortical cells have sufficient interfibrillar material between them (more amorphous portion) whereas paracortical cells have closed package of microfibrils with little interfibrillar material (more crystalline portion). Basic dyes preferably stain more

JAYPEE BROTHERS

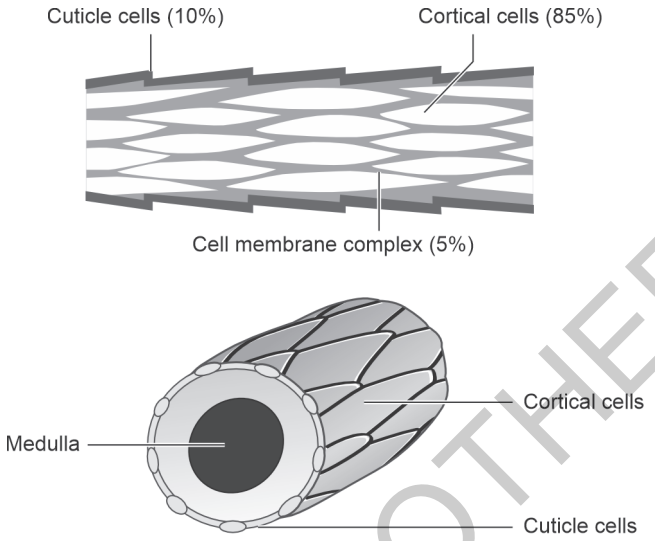

Fig. 24.5: Schematic arrangement of cells in wool.

accessible orthocortex whereas paracortex is less accessible to the staining dyes.

Medulla

Medulla is the inner most component of animal fiber. It is a network of hollow, air filled cell walls which in some cases collapse and form a hollow tube. It is a breed character. Medulla is absent in fine wool fibers, which generally consists of only cuticle and cortex. Some coarse wool fibers are partially medullated. Kemp fibers are highly medullated except near tip and root and medulla occupies most part of the fiber.

The presence of medulla is detrimental to the quality of wool. The spinning quality of medullated fiber is very low. Medullated fiber has a chalky white appearance. Under microscope, medulla appears black. Medullated fibers are light in weight. They can not be uniformly dyed. Carpet wools perform better when medullated fibers are less than 25% while higher proportions will lower the quality.

Chemical Structure of Wool

Clean wool fiber is made up of a protein called keratin, which has sulfur containig amino acids, mainly consisting of cysteine. In fact, out of 22

JAYPEE BROTHERS

naturally occurring amino acids, wool contains 18. The side groups of these amino acids could have hydrocarbon (hydrophobic), acidic carboxylic (-COOH) or basic amino (-NH) groups in addition to sulfur containing amino acids. In keratin, peptide chains contain polyamides.

In wool fiber, the polypeptide chains are joined together by covalent chemical bond called crosslinks or noncovalent physical interactions. The most important crosslinks are sulfur containing disulpide bonds which are formed during fiber growth by a process called keratinization (**Fig. 24.6**). Disulphide bonds in keratin fiber render it insoluble in water and somewhat resistant to physical as well as chemical attack. During processing, disulpide crosslinks help in setting the fabric. Another type of crosslink called isopeptide bond is formed between acid or basic group amino acids.

The noncovalent physical interactions also help to stabilize the fiber under both dry and wet conditions. The most important of these interactions are ionic interactions or 'salt linkages' that occur between acidic (carboxyl) and basic (amino) side chains. These are responsible for the amphoteric or pH buffering capacity of wool. These ionic groups also control the dyeing behavior of the fiber. Besides, hydrophobic interactions occur between hydrocarbon side groups of amino acids in peptide chains. Due to this, wool does not wet so easily.

Physical Properties of Wool

i **Color:** White, off-white, pale yellow, yellow, brown or black
ii **Fiber length:** 3.5–25 cm, long fibers required for worsted processing

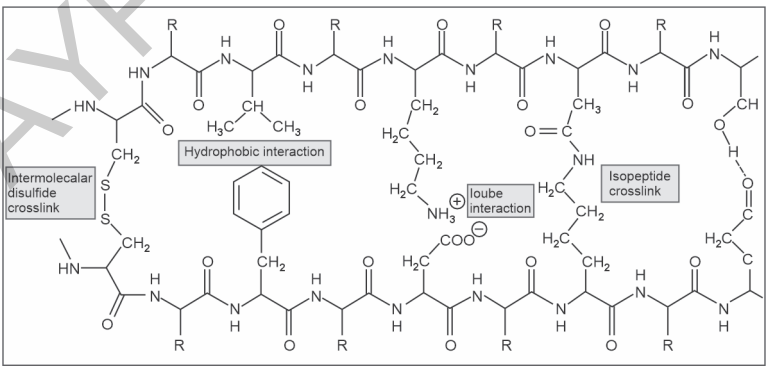

Fig. 24.6: Chemical structure of wool.

JAYPEE BROTHERS

iii **Fiber diameter:** Measured in micron to determine fineness
iv **Fiber contour:** Circular or oval
v **Clean dry yield or scouring yield:** 65–80% after removing the impurities by scouring
vi **Luster:** Gentle sheen or glow, depends on the reflection of light by the fibers, higher in coarse fibers
vii **Crimpness:** Number of waves/cm
viii **Specific gravity:** 1.31
ix **Moisture content (%):**

$$\frac{\text{Weight of moisture present in wool}}{\text{Total weight of wool}} \times 100$$

x **Moisture regain (%)**

$$\frac{\text{Weight of moisture present in wool}}{\text{Weight of dry wool}} \times 100$$

xi **Moisture swelling(%):** Swelling in fiber diameter on account of absorption of moisture. It is calculated at a temperature of 20°C and R.H. of 65%.
xii **Refractive index:** 1.55–5.00
xiii **Electrostatic reaction:** Highly electrostatic in dry condition
xiv **Vegetative content (%):** Estimation of burr content by dissolving wool in NaOH solution. Varies from 3–5% or sometimes slightly more.
xv **Hand feel:** Soft
xvi **Resiliency:** Excellent
xvii **Abrasion resistance:** Good
xviii **Dimensional stability:** Bad
xix **Elasticity:** Breaking extension–42.5%
Recovery-69 at 5%
xx **Elongation at break:** Standard elongation: 25–35%
In wet condition: 25–50%
xxi **Tenacity:** Weak fiber, low tensile strength
Dry =1.3g/d, lower in wet fiber
xxii **Heat of wetting:** Heat evolved as the wool gains moisture/water. It is estimated that 3.5 kg wool can absorb 0.7 kg of water and may evolve 81 kcal of heat.
xxiii **Effect of heat:** Does not burn freely when touched by flames but becomes harsh at 100°C and begins to decompose at higher temperature.
xxiv **Effect of light:** The fibers become weak and discolored on prolonged exposure and develop a harsh feel.

JAYPEE BROTHERS

for detailed information on veterinary books, visit our website www.jaypeebrothers.com, for detailed information on veterinary

Modern Abattoir Practices & Animal Byproducts Technology

This book contains 11 chapters on the key aspects of **modern abattoir practices**, 10 chapters on important areas of **animal byproducts technology**, and 1 each on **animal welfare, pet foods**, and **wool technology** in a systematic, clear, and concise form. The material has been carefully planned to deal with the subject in the tropical, especially Indian, context.

The book is intended primarily for the students of:

- BVSc and AH
- MSc (Food Technology)
- B Tech (Food Technology)
- MVSc (Livestock Products Technology)

It will serve as a useful handbook for meat industry personnel, especially:

- Field Veterinarians
- Meat Plant Managers and Supervisors
- Meat Processing Technicians

BD Sharma has been a meritorious graduate of Veterinary College, Pantnagar, Uttarakhand, India. He is one of the first few doctorates in the discipline of Livestock Products Technology (LPT). He joined Indian Veterinary Research Institute (IVRI), Izatnagar, Uttar Pradesh, as a Scientist in 1982 and served as Senior Scientist, Principal Scientist and Head, Division of Livestock Products Technology. He has 29 years of experience as a teacher and 34 years of experience as a scientist. As a faculty, he has guided 11 PhD and 17 MVSc students. He has 128 international and national research papers, 49 technical articles, 6 books, 18 book chapters, and 12 reviews to his credit. He has generated processing technologies of 14 meat products. He is the recipient of ICAR Dr Rajendra Prasad Award (2007–2008) and Best Teacher Award (2004–2005), besides other 32 awards/recognitions. He has held the prestigious position of Member, Board of Management, IVRI (2008–2010). He has been serving as expert to ASRB, IGNOU, GADVASU, GBPUA&T, LUVAS, CIPHET, SUKAST-K, and University of Allahabad.

Printed in India

Available at all medical bookstores or buy online at www.jaypeebrothers.com



JAYPEE BROTHERS
Medical Publishers (P) Ltd.
EMCA House, 23/23-B, Ansari Road,
Daryaganj, New Delhi - 110 002, INDIA
www.jaypeebrothers.com
Join us on facebook.com/JaypeeMedicalPublishers

Shelving Recommendation
VETERINARY

