LIFE & WORK SERIES

INTRODUCTION TO TEXTILE CHEMISTRY

H. HARPER

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BY

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PUBLISHERS' NOTE

In recent years the tendency of educational movements has been toward the extension of the work of the Elementary School. In Central and Senior Schools at appropriate stages, practical instruction suitable to the ages, abilities, and requirements of the pupils is being given. Courses of work for older pupils remaining at the elementary school beyond fourteen years of age must be provided, and measures taken for the preparation of those children who desire further education in schools other than elementary.

A new type of book is required for purposes of instruction under the new conditions; and the Life and Work Series is intended to supply it. The volumes in the series will be designed to satisfy two distinct ideals—one cultural and the other utilitarian or vocational—and in both cases the appeal will be through interest. It is not necessary to accept Rousseau's doctrine that a pupil should learn no lesson of which he does not feel the present need, yet he must have a consciousness of value if a dynamic response is to be secured. While the aim of education is to train young people to be worthy and working members of the community, the immediate task of the teacher is to detect incipient growth towards the light and to encourage it.

Contact with life and work will, therefore, be the common bond of the series. Compulsory attendance at school may be prescribed, but compulsory attention must come from the pupil's own being, and it can be just as successfully and usefully stimulated by the wonders or achievements of science and industry as by masterpieces of art and literature. Interest in the principles and processes of daily work is as worthy as a regard for what are called cultural studies, and both will foster a desire for further knowledge. Citizenship implies not only duty towards life in the community but also efficient work on its behalf on the part of the individual. It is hoped that the volumes in this series will, by their close touch with reality, satisfy the vital needs of young students and provide the nurture and stimulus which are the essential functions of all educational effort.

PREFACE

In the following pages a short account is given of some of the important properties of the textile fibres and the materials used in their treatment, but the chief object of the book is to provide a series of experiments illustrating these properties, in order to interest students of the various branches of textile work in the materials with which they deal. All the experiments can be carried out with the equipment found in an ordinary chemical laboratory.

Purely mechanical processes have been either omitted or treated very briefly, sometimes being merely mentioned. The principles of chemical reactions underlying manufacturing processes are dealt with in a simple manner, and should be readily understood by any reader who has an elementary knowledge of Chemistry.

Twelve years' teaching on the lines indicated in the book has convinced the author that students of textiles can be made to take a wider view of their own particular branch of the industry with ultimate benefit to the other branches.

The author is greatly indebted to the Editors, Sir Richard Gregory and Mr. A. T. Simmons, for much helpful criticism ; to the various firms for kindly supplying drawings and photographs of their machines and plant ; and to Mr. A. Langhorne of the Keighley School of Art for the microscope drawings of textile fibres.

H. HARPER.

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CHAPTER I

INTRODUCTION

TEXTILE FIBRES

Classes of textile fibres. The term, **textile fibres**, is applied to all fibres which are suitable for use in the manufacture of textile fabrics. Such fibres may be arranged into two groups, viz. natural and artificial, and the natural fibres may be further divided into animal, vegetable, and mineral fibres.

The representatives of the different classes are as follows :

Natural :
- Animal : wool, hair, silk.
- Vegetable : cotton, flax, hemp, jute, ramie, *etc.*
- Mineral : asbestos.

Artificial : the various artificial silks, the relatively unimportant spun glass, and metal threads.

Physical properties. The physical properties of a fibre determine its usefulness for the manufacture of particular fabrics ; and of these properties the most important are :

(*a*) Length or staple, and uniformity of staple.

(*b*) Tensile strength, by which is meant the force or strain to be exerted in the direction of the length of the fibre in order to break it.

(*c*) Pliability, which admits of the fibres being twisted together with little tendency to untwist.

(*d*) Elasticity, or the tendency of the fibre to regain its original length after being stretched. The elasticity of a

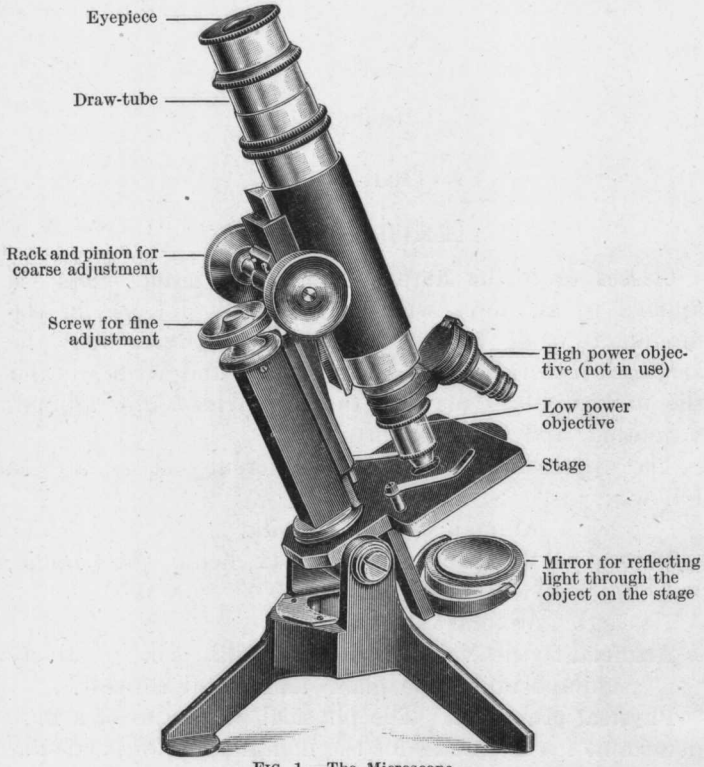


FIG. 1.—The Microscope.

fibre is, however, generally given as the percentage increase of length of the fibre before breaking. This is the elongation.

(*e*) Lustre.

(*f*) Durability or wearing quality.

(*g*) Conductivity for heat. Wool conducts heat badly, and woollen materials are therefore worn for warmth.

The fibre must also be cheap and obtainable in sufficient quantities.

Identification. Fibres may be identified by their physical properties and by their chemical properties; and the chemical reactions of the various fibres should be carefully noted in order that they may be used for identification. A collection of such reactions is arranged in tabular form at the end of the book. A very important method of identification depends upon the use of the microscope. The student should make himself perfectly familiar with this instrument in order to derive benefit from it. Much can be learned with low magnifications, say, of 50 to 80 diameters and, when experience has been gained with these, higher powers may be used.

Note.—Accustom yourself to use the microscope with both eyes open. If a sheet of paper or white cardboard be placed parallel to the stage of the microscope, the image of the object in the field of the microscope can be seen projected on it, and the outline of the image may be traced on the paper or cardboard.

EXPT. 1.—**Determination of magnifying power.** Place a stage micrometer, having lines 0·01 and 0·001 of an inch apart,

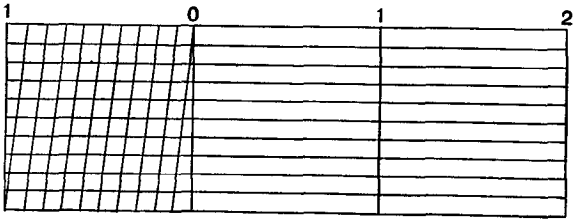


FIG. 2.—A Diagonal Scale.

on the stage of the microscope. Hold a diagonal scale, Fig. 2, parallel to the stage and read from it the distances between the lines of the stage micrometer as seen on the scale. Calculate

from these the magnification. Use other objectives in the microscope and calculate the different magnifications produced. Lines running from side to side of the stage are easier to read than those from front to back. If the magnifying powers of the microscope are given in the microscope box, compare your results with them.

EXPT. 2.—**To measure the thickness of a fibre.** Place the fibre across a slide on the stage of the microscope and read off the diameter of the image as seen on the diagonal scale. Divide the result by the magnifying power of the instrument to find the true diameter of the fibre. Find the thicknesses of at least six different fibres, and compare your results with the following:

Kind of Fibre.	Diameter in inches.
Leicester wool	0·00181
Australian merino	0·00052
New Orleans cotton	0·00097
Egyptian cotton	0·00072
Raw silk	0·00070
Flax	0·00063

EXPT. 3.—**Characteristic appearances of fibres.** Examine, sketch, and describe the appearances of wool, hair, cotton, flax, raw silk, boiled-off silk, etc. under the microscope, observing the ends and intermediate portions of the fibre. Note the scaliness of the wool fibre, the absence of scales of hair, the pointed ends of lambs' wool, the twisted appearance of cotton, the central canals of many fibres, etc.

Many chemical reactions may be carried out under the microscope, the fibre being touched with a drop of the reagent. These are called microchemical reactions.

QUESTIONS I.

1. Sketch and describe the appearance under the microscope of (*a*) wool, (*b*) cotton, (*c*) raw silk, (*d*) hemp, (*e*) jute.

2. Describe the properties on which the suitability of a fibre for textile purposes depends.

3. Describe carefully how you would determine the diameter of a textile fibre.

CHAPTER II

WOOL AND HAIR

Varieties of wools and hairs. Wools and hairs may be divided into the following chief varieties :

1. **Long wools**, such as those of the Leicester and Lincoln sheep.

2. **Cross-bred wools**, which are long stapled wools from many parts of the British Isles, the Colonies, and Argentine.

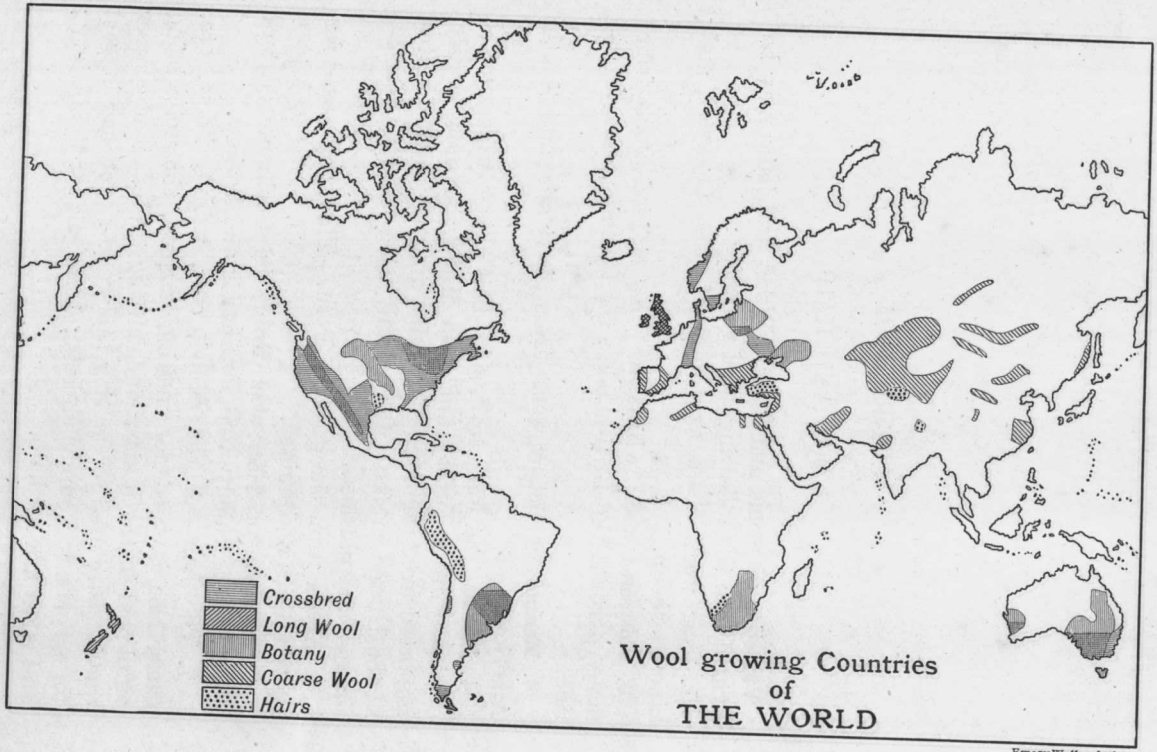
3. **Merinos** or **Botany wools** from Australia and South America.

4. **Mohair**, the long, stiff, silky hair of the Angora goat, originally from Turkey and Asia Minor, but now largely imported from the Cape, Australia, and the western states of the United States. It is chiefly used for dress fabrics, linings, and plushes.

5. **Alpaca** from the goats of Peru. This is also used for dress fabrics and linings.

6. **Cashmere** or **Tibet wool** from the Cashmere goat of Tibet. It is chiefly used for shawls and hosiery.

7. The hairs of the camel, cow, rabbit, horse, etc. **Camel hair** is used for making carpets, the noils being employed in the hosiery and hatting trade. The coarser qualities are used for belting and ropes. **Cow hair** is used for carpets, rugs, and blankets ; **horse hair** for upholstery ; and **rabbit hair** for hats.


Crossbred
Long Wool
Botany
Coarse Wool
Hairs
Wool growing Countries
of
THE WORLD
Emery Walker Ltd. sc.

8. The various recovered wools, such as shoddy, mungo, extract wool, etc.

The skin of animals. The skin consists of two distinct layers: (*a*) the **epidermis** or upper skin, and (*b*) the **dermis**,

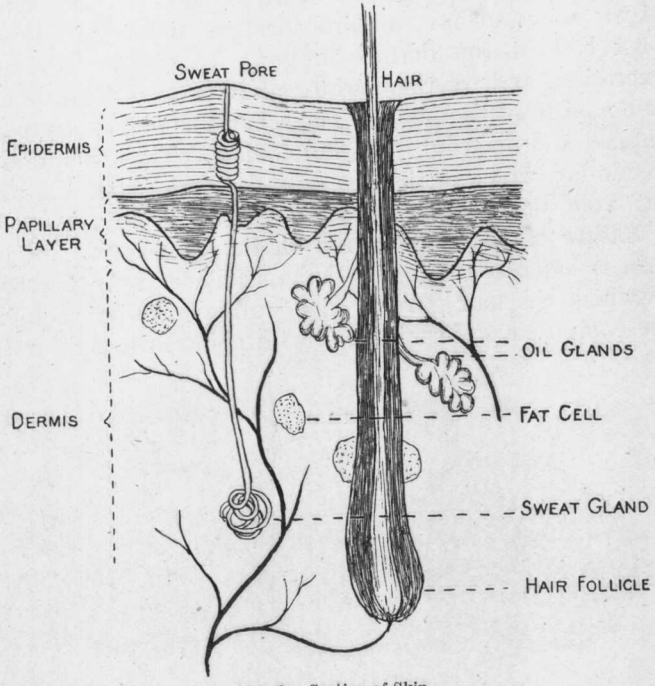


FIG. 3.—Section of Skin.

chorium or lower skin. The epidermis is divided into the **cuticle** or horny layer and the **retemucosum.** The cuticle is composed of the dead cells of the underlying retemucosum, which consists of living cells. The dermis is divided into the papillary layer and the dermis proper, and consists of connective tissue filled with a network of

blood vessels, glands, and nerves. The nerves end in the papillae.

Glands. In the dermis there are two kinds of glands, the **sweat** or *sudoriparous* glands and the **fat** or *sebaceous* glands. The sweat glands open at pores in the surface of the skin and have a spiral form terminating in a complex coil in the dermis proper. They are organs of excretion, and by them water and waste substances are removed from the body. The sebaceous glands are pear-shaped and open into the hair follicle. They secrete and exude fat, which in the case of sheep constitutes the wool fat, yolk, or Yorkshire grease.

Nature of hair follicle and shaft. The surface of the skin is indented with pits or hair follicles from the base of which the hair grows. The walls of the hair follicles are composed of dermis lined with epidermis, and, at the

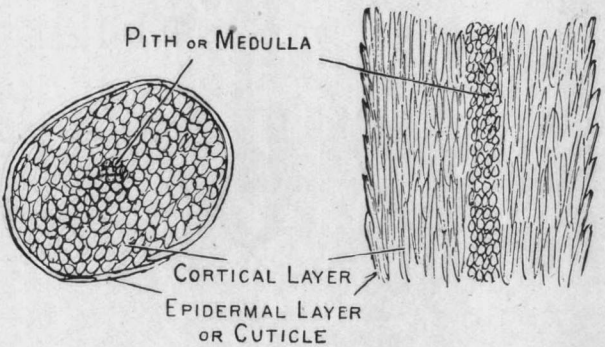


FIG. 4.—Sections of Hair.

bottom of the follicle, the dermis rises up into a vascular papilla which is furnished with special blood vessels to supply nourishment to the epidermal cells which are produced there. The multiplication of the epidermal cells