was accompanied by a decrease of tyrosin, pointing to the fact that some ferment action had been going on to produce the pigment. The production of pigment can be looked upon, then, as a metabolic process, affecting the proteid molecule of the cell, this metabolic change being due to the action of a ferment.

The further connection between metabolism and pigment formation is clearly shown in ochronosis, where the cartilage of the body becomes black. Ochronosis is associated with alcaptonuria, which is a disease affecting normal metabolism, *i. e.* the body loses the capacity of breaking up completely the aromatic group of the proteid molecule, viz. tyrosin and phenylalanin. Instead, oxidation products of these substances circulate in the body as homogentisinic and uroleucinic acids, and become excreted through the kidneys. These acids are capable of producing pigmentation of cartilage.

THE FUNCTIONS OF THE SKIN.

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Lecture VI.

The skin of man is characterised by its nakedness and the great development of the sweat-glands; it is, moveover, richly supplied with small blood-vessels, the size of which is controlled by the nervous system. When the body is too hot these vessels are dilated, and thus expose more blood to the cooling effect of the air or the evaporation of sweat. On the other hand, the vessels are contracted, and the blood is confined chiefly to the deeper parts of the body, when the loss of heat would be injurious. This naked condition of the skin is a great advantage, for it enables man by means of artificial clothing and shelter to withstand a greater range of temperature and climate than any other animal.

The temperature of the skin is liable to great variations in health and disease, but, as in the case of many common conditions, it has not been the subject of many exact investigations. The expressions, "a hot skin" and "a cold skin," we constantly use, but if we are

asked to state in more definite terms what we mean we at once find how ignorant we are. Our sensations tell us that the skin is hot or cold, as the case may be, but knowledge obtained by our sense of temperature must always be inexact. Our standard is the temperature of our own skin, and that is liable to great variations. A thermometer must be used if we wish to determine the temperature of the skin more exactly, and it is necessary to insist that the thermometer is an instrument which should be used with intelligence. The prevalent idea is that the determination of temperature is so simple that it can be left to the nurse, and that the medical student requires no instruction in its use. The result is that most of the clinical charts as records of temperature are of little scientific value.

The temperature of the skin is related to its vascularity and to its secretions. It is possible, therefore, to study it indirectly as well as directly. The colour of the skin is a guide to its vascularity: white, when the vessels are uniformly contracted, and contain but little blood; red, when the vessels are dilated and well filled; and blue, or as the saying is, "blue with cold," when the contraction is not uniform and the blood is stagnant in some of the smaller vessels. The extremes can be easily recognised, but it is impossible to fix a standard for health. Some healthy subjects have naturally a pale skin, although there is no lack of blood or blood-pigment in the body; it may be that their skin is not so vascular, or that the cutaneous vessels are in a state of greater tone. Other subjects have a very sensitive nervous control of their vessels; the skin of their extremities quickly responds to changes of external temperature. The response may be so pronounced that on exposure to cold their fingers and toes "die away," and become quite bloodless. This is not caused, as many suppose, by failure of the heart, but to a local cessation of the flow of blood due to a contraction of the small arteries sufficient to withstand the pressure of the blood.

There are two methods in use for the determination of the temperature of the skin—the mercurial thermometer, with a flat bulb, and the thermo-electric pile or needle. Good results can be obtained with the former method, as John Davy, Waller, and others have shown. It is true that there may be sources of error, but these are more than counterbalanced by the ease with which observations can be made as compared with the complicated apparatus required for thermo-electric

work. This contention will be substantiated best by a comparison of the results obtained by different observers, some of whom have used the one method, some the other. The following table affords such a comparison:

Method. Observer.	Mercurial thermometer. J. Davy.		Mercurial thermometer. M. S. Pembrey.		Mercurial thermometer. B. A. Nicol.		Thermo-electric. Kunkel.		Thermo-electric. G. N. Stewart.	
	C.	F.	C.	F.	C.	F.	C.	F.	C.	F.
Temperature of air	21°	(69·8°)	10°	(50°)	19·5°	(67·1°)	20°	(68°)	18·3°	(64·94°)
Forehead	—		—		—		34·1°	(93·38°)	33·04°	(91·47°)
Hand, back of	—		26·25°	(79·25°)	31°	(87·8°)	32·5°	(90·5°)	—	
Hand, palm of	—		30°	(86°)	32·5°	(90·5°)	34·4°	(93·92°)	30·95°	(87·71°)
Forearm	—		30·8°	(87·44°)	33·4°	(92·12°)	33·7°	(92·66°)	34°	(93·2°)*
Arm	—		—		—		—		35°	(95°)*
Chest	34·44°	(93·99°)	—		—		34·6°	(94·28°)	34·57°	(94·22°)
Abdomen	35°	(95°)	34°	(93·2°)	34°	(93·2°)	34·6°	(94·28°)	35·16°	(95·29°)
Thigh	34·44°	(93·99°)	33°	(91·4°)	32°	(89·6°)	34·2°	(93·56°)	—	
Leg, calf of	33·89°	(93°)	31°	(87·8°)	32°	(89·6°)	33·6°	(92·48°)	—	
Foot, sole of	32·2°	(89·96°)	—		—		—		31·05°	(87·89°)

* Temperature of air in this case = 17·6° C. (63·68° F.)

An examination of the table shows that the temperature of the skin of the trunk is much more constant than that of the extremities. There is no uniformity in the temperature of the healthy body; the temperature is not constant in health notwithstanding the fact that it is often said to be so, and that clinical thermometers and temperature charts are marked with a line at 98·4° F. (36·89° C.) for the normal. The absence of uniformity is a sign of health and well-being; we are comfortable and unconscious of the fact that there are local differences in temperature which at once become manifest when we place our hands in succession on the face, chest, abdomen, and foot. As soon as the external conditions, such as heat, moisture, and absence of wind, become favourable for the development of a more uniform temperature of the body, discomfort and inefficiency arise. This question is one of the greatest importance in relation to the influence of climate and artificial systems of heating dwellings and work-rooms, and it is unfortunate that many authorities have overlooked the physiological aspect. In living things there is no uniformity, and all attempts to obtain uniformity in religion, politics, work, or social standing have failed. Uniformity would mean absolute stagnation—death.

The extravagant and dusty open fire is better than the closed stove or the radiators filled with hot water or steam, for it produces more variation in the temperature of the room, and this reacts upon the skin. Changes in the temperature of the skin stimulate the nervous system and produce a more steady growth and greater activity of body and mind. It would be a digression, however, to pursue this subject further, but there is little doubt that our variable climate is a blessing in disguise.

The value of determinations of the temperature of the skin lies, not only in the data obtained upon the distribution of heat in the body, but also in the evidence which, in conjunction with the values obtained for the internal temperature, it affords of the production of heat. If the internal temperature remains normal and the surface temperature is increased, a greater production of heat is indicated, provided that the external conditions be the same. This line of argument can be extended to variations of both internal and surface temperature, and conclusions can be drawn upon the questions of the production and loss of heat in health and in fevers.

The conditions which influence the temperature of the skin can be divided into two groups—the external and the internal. Of the former the most important is climate, which comprises temperature, moisture, and wind. The physiological effect of external temperature must be considered in relation to that of moisture, for it is not the reading of the dry bulb thermometer which is important as a guide so much as that of the wet bulb, which indicates how rapidly evaporation of moisture from the skin can occur.

A warm, stagnant, and moisture-laden atmosphere has a depressing effect upon the people exposed to it; it diminishes their activity, both physical and mental. The effect of work under such conditions is to increase the temperature, pulse, and loss of moisture out of proportion to the work done. Efficient work cannot be performed unless the temperature of the body is prevented from rising above a certain optimum. The temperature depends upon the production and the loss of heat; work increases the production, and the passage of more blood through the vessels of the skin and the evaporation of sweat increase the loss. A warm, moist, and stagnant atmosphere hinders the loss and taxes the power of accommodation of the worker. The result is that he either does less work or unwisely neglects the

warning which he receives from his sensations and works at an uneconomical rate, to the detriment of his health.

When the temperature of the air is high both by the dry- and wet-bulb thermometers, the evaporation of sweat must be greatly increased in order to cool the body. This is shown by a comparison of the following results obtained upon soldiers when they performed a march of seven miles on hot and cold days with the same clothing, equipment, and load.

No. of men.	Increase in pulse.			Increase in rectal temperature.			Loss of moisture from body in grammes.			Increase in weight of clothes in grammes.			External temperature.	
	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Dry Bulb.	Wet bulb.
4	84	52	62	2·3° F.	0·6° F.	1·4° F.	2390	1140	1816	640	60	320	79°	67·5°
4	24	8	14	1·6° F.	0·0° F.	0·8° F.	555	300	419	40	0	27	45°	38°

Cold acting upon the skin produces reflexly a greater tone of the muscles of the body, makes muscular activity a pleasure, and increases the appetite. A cold bath in the morning is of value not so much for its cleansing properties as for the stimulating effect which it produces upon the nerves and muscles of the body. The skin is subjected to a sudden change from the warmth of the bed, and thus the nervous system of the man is trained to meet variations of temperature; his cutaneous vessels contract and thus prevent undue loss of heat. By practice he becomes immune to the effects of changes of temperature and less liable to chills.

The influence of clothing upon the temperature now requires consideration. Under ordinary conditions only the face and hands of Europeans are freely exposed to the air; the body and limbs are protected by clothes, and are surrounded by a layer of air with a temperature intermediate between the temperature of the skin and that of the external air. The main purpose of clothing is this inclusion of air; the different articles of dress form strata with different temperatures. The greater part of the surface of the skin is thus exposed to air which is warm, even when the external air is cold.

The air included in the pores of the clothing and between the

different articles of dress has been estimated at twenty to thirty litres. The radiation and conduction of heat from the skin are diminished by clothing, and thus the temperature of the skin is maintained at a higher point than it would be if it were uncovered. This higher temperature will increase the loss of moisture from the body, but the net result is a saving of about 20 per cent. of the heat loss at a temperature of 15·56° C. (60° F.).

During muscular work in hot weather the clothes may retain large quantities of sweat if there be no free circulation of air. The cooling effect of sweating is partly lost in such cases, for it takes place from the surface of the clothes and only affects the skin through the layers of wet underclothing. The opening of the jacket, waistcoat, and shirt will bring about not only comfort, but also the most effective use of the moisture discharged from the body. There is no doubt that the greatest discomfort arises when the temperature of the skin is abnormally raised. It is in the skin that the sensations of heat and cold arise. An increase in both the deep and surface temperature shows that the body is warmed in all its parts and discomfort is then experienced; if, on the other hand, the skin be kept cool by sweating or exposure, no discomfort and no bad effects are experienced by a healthy man whose internal temperature has been raised a degree or two by hard work.

A man works more slowly when he feels too hot, or if he wishes to continue to work hard he increases the loss of heat from his skin by the removal of his coat and waistcoat, and by turning up his sleeves. The evaporation of sweat is thus facilitated, as shown by the following comparative observations upon soldiers after a march of seven miles:

No. of men.	Increase in pulse.			Increase in rectal temperature.			Loss of moisture from body in grammes.			Increase in weight of clothes in grammes.			External temperature.	
	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Dry bulb.	Wet bulb.
5*	52	16	28	1·6° F.	0·6° F.	1·0° F.	1430	1000	1200	250	0	109	67°	58°
5†	48	24	41	1·8° F.	0·8° F.	1·5° F.	2000	1200	1500	480	90	254	69°	59°

* Drill order without jacket.

† Drill order with jacket.

In both cases the men performed the same march with the same equipment and load, but in the first they did not wear their jackets, in the second they did.

There is little doubt that observations upon the deep and surface temperatures of the body and the loss of sweat would throw much light upon the effects of different trades and occupations, in which the workers are exposed to hot air laden with moisture.

REFERENCES.

Temperature of Skin; Loss of Moisture.

DAVY, J.—*Phil. Trans.*, London, vol. civ, 1814, p. 590; *Researches*, London, vol. i, 1839, p. 150.

WALLER.—"Proc. Physiol Soc.," *Journ. Physiol.*, vol. xv, 1894.

KUNKEL.—*Ztschr. f. Biol.*, Bd. xxv, 1889, S. 55.

STEWART.—*Stud. Physiol. Lab., Owens Coll., Manchester*, vol. i, 1891, p. 100.

PEMBREY.—Article, "Animal Heat," in *Text-book of Physiology*, edited by Schäfer, vol. i, 1898, p. 829.

PEMBREY and NICOL.—*Journ. Physiol.*, vol. xxiii, 1898–9, p. 386.

TIGERSTEDT.—*Handbuch der Physiologie des Menschen*, von Nagel, Bd. i, 2ter Hälfte, 1906, S. 557.

ZUNTZ and SCHUMBURG.—*Studien zu einer Physiologie des Marsches*, Berlin, 1901.

Committee on Physiological Effects of Food, Training, and Clothing on the Soldier. Second and Fourth Reports, 1908. *Journ. Royal Army Medical Corps*, vol. xii, 1909, p. 211, and vol. xiii, 1909, p. 592.

CURRENT LITERATURE.

THE ÆTIOLOGY OF EPIDERMIDOLYSIS BULLOSA. M. F. ENGMAN and W. H. MOOK. (*Interstate Med. Journ.*, July, 1910, p. 499.)

THE histological examination of four cases has been already reported by the writers. In a fifth case the patient was the youngest of thirteen children, none of whom had ever suffered from any skin-disease, and none of his ancestors on maternal or paternal side had ever been known to have a similar affection.

Examination revealed numerous large and small bullæ on his hands, forearms, neck, and a few on the face. Some were serous, some sero-sanguineous, and a few on the hands were hæmorrhagic. There was considerable secondary staphylococcic infection. His mother stated that a blister was noticed on his left heel a few days after birth, and that ever since that time the blisters followed any slight or severe injury on any portion of his body. Examination of his body revealed numerous large and small superficial cicatrices, generally at points of irritation, such as buttocks, waist-line, ankles, where shoes were laced, and on his neck. The nails were rough, corrugated, some partially destroyed, though none entirely