R34.6

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Physics in Relation to Hygiene.

First Lecture: Climate and Civilisation: Thermometry.

It is necessary to have some knowledge of physics in order to realise how the physiological functions of man are affected by environment.

The interchange of energy, in the form of heat, which is always taking place between the body and its surroundings.

The average man, resting as whilst sitting, as in a theatre, loses about 400 British Thermal Units por hour - much more if he is doing hard work. Were he not able to lose this amount of heat his body temperature would rise.

A British Thermal Unit (B.Th.U.) is the amount of heat required to raise one pound of water, through one degree Fahrenheit. One B.Th.U. = 252·0 small calories.

Heat is transferred in three ways:-

Conduction e.g. Holding a cold iron bar.

Convection Moving air or water particles touching the warm surface and carrying heat away.

Radiation Heat, in the form of invisible rays of comparatively low frequency can pass through the air without warming it to cold solid surrounding (e.g. a cold wall in winter time) or to the unclouded night sky.

Huntington found a close connection between the average temperatures obtaining in different parts of the world and the characteristics (degree of civilisation) of the inhabitants.

There is also a marked seasonal variation in the incidence of some epidemics which may well be accounted for by the temperature changes.

The output of factories is found to vary with the time of year. In the tinplate industry Vernon found that the falling off of output that takes place in the summer can to some extent be obviated by good ventilation.

THERMOMETRY.

The chief precaution in taking the temperature of the outside air is to protect the thermometer from radiation (either plus or minus).

In this country the Stevenson screen is used. It usually contains mercurial dry and wet bulb thermometers, a mercurial maximum thermometer and an alcohol minimum thermometer.

In this country meterological thermometers are graduated between -15 ^{o}F. and 115^{o}F.

Six's mercurial combined maximum and minimum thermometer: not very accurate.

Black Bulb Radiation thermometers - intended to measure the radiation received from sun and sky.

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BODY TEMPERATURE REGULATION

Effects of Heat and Cold.

Body temperature is maintained practically constant by balance between heat production and heat loss. Heat production at rest: 75 Calories or 400 British Thermal Units per adult per hour.

In still air, temperature 59°F., Relative Humidity 50 per cent. a clothed sedentary individual loses heat in approximately the following proportions:- by radiation 45 per cent., by convection 31 per cent. by evaporation 24 per cent. This fractional proportionate loss of heat is affected by air temperature, humidity, and movement and by radiation from the surroundings.

Loss of heat by radiation and convection can only occur if the temperature of the air and surroundings is less than body temperature.

Loss of heat by evaporation depends on the humidity of the air and its temperature and movement.

Reactions to heat: Physiological: (i) dilatation of cutaneous arterioles with result that more blood circulates through skin and heat loss by convection, radiation and evaporation is increased. (ii) Sweating: on evaporation, 1 grammo of water absorbs 585 small calories.
Artificial: Clothing: shelter: use of fans.

Reactions to cold: Physiological: (i) constriction of peripheral vessels and reduction in heat loss by convection and radiation; (ii) decreased sweating; (iii) increased heat production by shivering, internal secretions; muscular activity.
Artificial: Clothing; shelter: protection against wind, rain, etc.

FAILURE IN ADAPTATION TO HEAT.

High atmospheric temperatures, high humidities, intense radiant heat may impose an excessive strain on the temperature regulating mechanism of the body particularly if the individual is performing muscular work with associated increased internal heat production. Unsuitable clothing and pathological conditions predispose to failure of adaptation to heat.

Heat stroke, heat hyperpyrexia or heat apoplexy: normal mechanism of body temperature regulation affected.

Body temperature raised 106-110°F. Pulse rapid at onset.
Sweating inhibited: skin hot and dry.
Dyspnoea.
Nervous symptoms: excitement: struggling: delirium: convulsions.
Thirst.
Body temperature must be reduced by artificial means:- drenching skin, exposure to cool air, fanning.

Heat Collapse, heat exhaustion, heat prostration or heat syncope: This condition is due to cardio vascular insufficiency.

Body temperature: subnormal or normal unless condition of disease present.
Pulse weak.
Sweating profuse. Skin cold and moist.

Blood pressure reduced.
Giddiness, fainting, fatigue, sense of exhaustion, collapse.

Strain on heart and circulation must be relieved by lying patient down, and if necessary massage of limbs and body to improve venous return. Clothing should be loosened and patient moved to coolest place available and given access to fresh air.

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Measurement of Oxygen Cost and Efficiency of Muscular Work.

Date: | **Time of Commencement:** | **Place:**

Subject. | Ht. | Wt. | Last Meal, Nature:

Time:

Detail	**Observation** 1.	Work 2.	Recovery 3.
Foreperiod 20 mins			
Posture or Work Sitting			
Time of collection 5 mins			
Pressure			
Temperature 72			
Bag Volume 36.0			
Corrected Bag Volume dry N.T.P.			
Ventilation per min.			
Sample No. 8			
Vol. of Sample 90.54			
- CO_2			
- O_2			
Vol. CO_2			
Vol. O_2			
% CO			
% O_2			
% N_2			
∴ % O_2 inspired			
CO_2 expired			
% O_2 used			
Respiratory Quotient			
O_2 used per min.			
Total O_2 used work and recovery			
Resting O_2			
O_2 Cost of work			
(X) Cal. equivalent of O_2			
Work done Kgm. metres			
(Y) Cal. equivalent of work			
Efficiency $\frac{Y}{X} \times 100$			

1½ hrs exp. period. Reading of meter 80.1155

Admiral Fitzroy's Weather Rules.

Whether clear or cloudy, a rosy sky at sunset foretells fine weather. A sickly grayish hue, wind and rain. Tawny or coppery clouds wind. Dark or indian red, rain.

Red sky in morning, bad weather or much wind; grey - fine weather. A 'high dawn', wind; a 'low dawn', fair weather. A 'high dawn' when first indications of daylight are seen above a bank of clouds, a 'low dawn' when the day breaks on or near the horizon, the first streaks of light being very low down. Soft looking or delicate clouds foretell fine weather with moderate or light breezes. Hard-edged oily looking clouds foretell wind.

A dark gloomy blue sky is windy but a bright light blue sky indicates fine weather. Generally speaking, the softer clouds look, the less wind, but perhaps more rain may be expected, and the harder, greasier, rolled, tufted or ragged they appear the stronger the coming wind will prove. Also, a bright yellow sky at sunset foretells wind; a pale yellow, wet. Orange or copper coloured, wind,and rain, and thus by the prevalence of red, yellow, green or other tints the coming weather may be foretold very nearly, indeed, if aided by instruments, almost exactly.

Light, delicate, quiet tints or colours with soft forms of clouds indicate and accompany fine weather. But gaudy or unusual views with hard definitely outlined clouds foretell rain and probably strong wind.

Small inky looking clouds foretell rain. Light scud clouds driving across heavy masses show wind and rain; if alone they indicate wind only, proportionate to their motion. High upper clouds crossing sun, moon or stars in a direction different from that of the lower clouds, or the wind then felt below, foretell a change of wind towards their direction. In middle latitudes these upper currents are not so very frequent except before a change of weather.

After fine clear weather, the first signs in a sky of a coming change are usually light streaks, curls, whisps or mottled patches of white distant cloud, which increase and are followed by an overcasting by a murky vapour that grows in cloudiness. This appearance more or less oily or watery as wind or rain will prevail is an infallible sign.

Usually, the lighter and more distant such clouds seem to be, the more gradual but general the coming change of weather will prove. Misty clouds forming or hanging on heights show wind and rain coming if they remain, increase or descend; if they rise or disperse the weather will improve or become fine.

Dew is indication of coming fine weather. Its formation never begins under an overcast sky or when there is much wind.

Remarkable clearness of atmosphere, especially near the horizon, distant objects such as hills unusually visible or well defined or raised by refraction, and what is called a good 'hearing day' may be mentioned among signs of wet if not wind to be expected in a short time. Much refraction is a sign of easterly wind. Unusual twinkling of stars or apparent size of the stars, indistinctness or apparent duplication of the moon's Horns, are more or less significant of increasing wind if not approaching rain, with or without wind.

Lighting in the N.W. in the North Atlantic never fails to be followed by a heavy gale from the same quarter.

Metabolism by Indirect Calorimetry.

(Douglas Haldane Method.)

8/10/37

Detail.	Observations.		
	I.	II.	III.
Subject.			
Fore period.			
Posture or work.			
Time of Collection.			
Pressure.			
Temperature.			
Bag volume.			
Corrected Bag volume			
Ventilation per min.			
Sample No.			
Vol. of Sample.			
- CO_2			
- O_2			
Vol. CO_2			
Vol. O_2			
% CO_2			
% O_2			
% N_2			
% O_2 inspired			
CO_2 expired.			
O_2 used.			
Respiratory Quotient.			
O_2 used per min.			
Cals. per litre O_2			
Cals. per min.			
Surface Area.			
Cals. per sq. meter per hr.			
Metabolic Rate.			

BEAUFORT SCALE.

Beaufort Number.	General Description of wind.	For Coast use.	For use on Land.	Limits of Velocities.	
				Miles/hr. (Statute)	Metres/sec.
0	Calm.	Calm.	Calm. Smoke rises vertically.	Less than one	Less than 0·3
1	Light air.	Fishing Smack just has steerage way.	Direction of wind shown by smoke drift but not by vanes.	1 - 3	0·3-1·5
2	Slight Breeze.	Wind fills sails of Smacks which move from 1 - 2 M.P.H.	Wind felt on face; leaves rustle. Ordinary Vane moved by wind.	4 - 7	1·6-3·3
3	Gentle Breeze.	Smacks begin to heel over; travel 3 - 4 M.P.H.	Leaves and small twigs in constant motion. Wind extends a light flag.	8 - 12	3·4-5·4
4	Moderate Breeze.	Good working breeze. Smacks carry all courses with good list.	Raises dust and loose paper; small branches are moved.	13 - 18	5·5-8·0
5	Fresh Breeze.	Smacks shorten sail.	Small trees in leaf begin to sway. Crested wavelets form on inland waters.	19 - 24	8·1-10·7
6	Strong Breeze.	Smacks double reef mainsail.	Large branches in motion. Whistling in telegraph wires.	25 - 31	10·8-13·8
7	High wind.	Smacks remain in harbour.	Whole trees in motion. Inconvenience felt when walking against wind.	32 - 38	13·9-17·1
8	Gale.	All Smacks make for harbour.	Breaks twigs off trees. Generally impedes progress.	39 - 46	17·2-20·7
9	Strong Gale.	----------	Slight structional damage occurs.	47 - 54	20·8-24·4
10	Whole Gale.	----------	Trees uprooted. Considerable structional damage.	55 - 63	24·5-28·4
11	Storm.	----------	Widespread damage.	64 - 75	28·5-33·5
12	Hurricane.	----------	----------	Over 75	33-68 and above.