Anatomy and Physiology Homeostasis: Lab

Student Name: ____

Pre-Lab: Homeostasis Notes, Body Temperature Activity + Video; Introduction in this Lab.

Homeostasis: The Link with Health

The word homeostasis literally translates to "same standing" and is usually taken to indicate constancy or balance. The body regulates homeostasis by using hormones and neural mechanisms. In order to perform the basic function of the life successfully, there must be a consistency within the body and in particular in the environment inside cells, called the intracellular fluid. The regulation of the composition and volume of fluids that surround cells is called the extracellular fluid. This fluid baths the cells and acts as an intermediary between the cells and blood. In addition, the plasma in blood works to circulate nutrients that need to find their way into the body and wastes that need to find their way out. Two processes which strive to keep the body in balance is the intake of raw materials and the removal of waste products of chemical reactions—or their ability to store, destroy or transform these substances to others inside the human body.

Principles of Homeostasis

Homeostasis is a condition, which may vary but remains in a relatively constant range. We call that the homeostatic range. Our body strives to stay within this range. When it has difficulty staying in homeostasis it is an indicator of disease, injury or susceptibility within the body.

The table on the right (1.3) shows the normal range a physician would use to detect homeostatic imbalance. It is important to note that one person's normal levels could fluctuate just above the minimum values of the range while another person's could fluctuate close the maximum values.

It is also important to point out that "normal" means conforming to the usual healthy pattern and that is the statistical parameters for 95% of the population. That means that 5% of the population will not fall into traditional "normal" ranges.

Therefore the body is trying to preserve the internal environment that is optimal for cell function at any moment in time, despite the level of activity of the individual.

Table 1.3 Normal laboratory blood values*

Clinical chemistry	Normal adult value (homeostatic range)
Sodium	136–148 mmol/L
Potassium	3.8–5.0 mmol/L
Bicarbonate	24–32 mmol/L
Urea	2.6–6.5 mmol/L
Creatinine	60–120 mmol/L
Glucose	Random, 3.0–9.4 mmol/L
CSF glucose	2.5–5.6 mmol/L
Total protein	62–82 g/L
Albumin	36–52 g/L
Globulin	20–37 g/L
Calcium	2.2–2.6 mmol/L
Transaminase	Up to 35 IU/L
pH	7.35–7.45
PCO_2	4.7–6.0 kPa
PO_2	11.3–14.0 kPa

CSF, cerebrospinal fluid; PCO_2, partial pressure of carbon dioxide; PO_2, partial pressure of oxygen.

*Note values are guides for judging health and disease. These ranges have proved to be clinically useful for judging health, disease and recovery in hospital wards and clinics

***Q** Describe in scientific terms what is meant by the term 'normal range' when equated with the values expressed in clinical laboratory tables.*

Homeostatic Controls

Negative Feedback

Most homeostatic control mechanisms operate on the principles of negative feedback. When a homeostatic disturbance occurs, it triggers the built-in self-adjusting mechanisms, which try reversing the deviation. For example, the regulation of blood sugar demonstrates the principle of negative feedback control. An increase in blood glucose concentration above its homeostatic range sets into motion processes that reduce it. Conversely, a blood glucose concentration below its homeostatic range promotes processes that will increases it. It both situations, this ensures the level of blood sugar remains constant overtime. The only way to stop a negative feedback loop is to balance the system by offering a counterpoint or solution.

Positive Feedback

Positive feedback occurs when we want to promote a value above the homeostatic range rather than returning the value within a homeostatic range. Positive feedback occurs when the results increase the response—which in turns promotes a further increase in the response. An example of positive feedback occurs when a woman is lactating. When her baby cries it stimulates her mammary glands to release milk; as the baby suckles the milk, that stimulus also promotes more milk to be released and triggers the mammary glands to make more milk for future use. The only way to stop a positive feedback loop is to remove the stimulus—in this case; prevent the baby from breastfeeding to prevent the action from promoting the production of milk.

Part I: Lab: It's Fun to be Fit

Objective: Determine how the body deals with the effects of exercise in terms of heart rate, blood pressure and temperature.

Background: ***Heart rate*** is a term to describe the number of beats the heart makes in a unit of time. Usually it is calculated as the number of contractions (beats) of the heart in one minute and is generally expressed as "beats per minute" (bpm). When resting, the typical adult human heart beats at about 70 bpm in men and 78 bpm in woman. Infants and children have higher heart rates.

WOMEN'S RESTING HEART RATE CHART						
AGE	18 - 25	26 - 35	36 - 45	46 - 55	56 - 65	65+
ATHLETE	54-60	54-59	54-59	54-60	54-59	54-59
EXCELLENT	61-65	60-64	60-64	61-65	60-64	60-64
GOOD	66-69	65-68	65-69	66-69	65-68	65-68
ABOVE AV	70-73	69-72	70-73	70-73	69-73	69-72
AVERAGE	74-78	73-76	74-78	74-77	74-77	73-76
BELOW AV	79-84	77-82	79-84	78-83	78-83	77-84
POOR	85+	83+	85+	84+	84+	84+

MEN'S RESTING HEART RATE CHART						
AGE	18 - 25	26 - 35	36 - 45	46 - 55	56 - 65	65+
ATHLETE	49-55	49-54	50-56	50-57	51-56	50-55
EXCELLENT	56-61	55-61	57-62	58-63	57-61	56-61
GOOD	62-65	62-65	63-66	64-67	62-67	62-65
ABOVE AV	66-69	66-70	67-70	68-71	68-71	66-69
AVERAGE	70-73	71-74	71-75	72-76	72-75	70-73
BELOW AV	74-81	75-81	76-82	77-83	76-81	74-79
POOR	82+	82+	83+	84+	82+	80+

To determine if an individual's cardiovascular system is operating in homeostasis we can look at their resting heart rate before exercise using the charts above. A human body in the above average to poor range would have to work extra hard to maintain homeostasis and therefore would be at risk for cardiovascular disease.

Measuring the difference between the resting heart rate and the heart rate during exercise can give a relative indication of overall fitness level. Recovery heart rate is another measure of fitness. This refers to the heart's ability to return to normal rhythm after being elevated during exercise. A fast return to the resting heart rate after exercise is another indicator of overall fitness and good homeostatic control.

To calculate the overall fitness of an individual you can look at how quickly the cardiovascular system recovers from exercise (returns to homeostasis) you need the following:

a. Maximum heart rate achieved
b. Heart rate exactly 1 minute after exercise has concluded

Maximum heart rate – 1 minute heart rate = recovery heart rate
The difference between these two measurements will tell you your overall fitness.

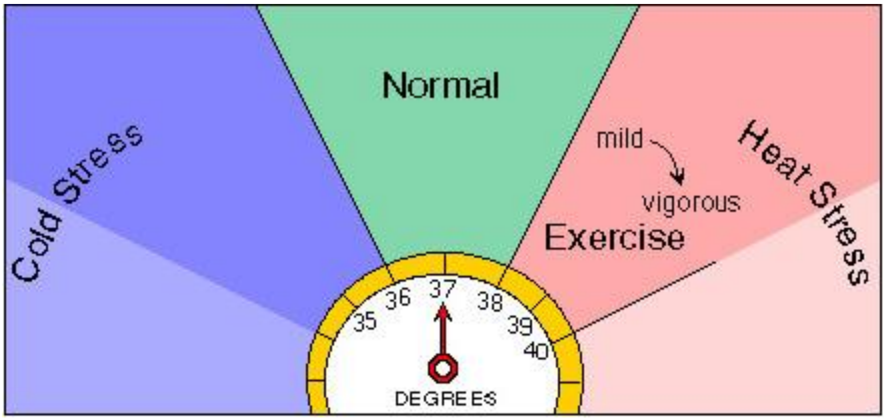
- <10 = extreme caution
- 11-20 = Low
- 21-40 = Good
- 41-50 = Excellent
- 50 = Fit Athlete

Normal resting blood pressure is less than 120/80 mmHg. The first number, 120, represents the systolic pressure, or pressure against the artery walls when the heart contracts. The lower number, 80, is the diastolic pressure, or pressure against the artery walls between heart beats.

During exercise, the systolic pressure increases progressively as the cardiovascular system attempts to deliver more oxygen to the working muscles. The diastolic pressure (the lower number) should stay about the same, or decrease slightly, thanks to the dilated blood vessels in the working muscles that help heat escape.

Age	Min	Normal	Max
1 to 12 months	75 / 50	90 / 60	100 / 75
1 to 5 years	80 / 55	95 / 65	110 / 79
6 to 13 years	90 / 60	105 / 70	115 / 80
14 to 19 years	105 / 73	117 / 77	120 / 81
20 to 24 years	108 / 75	120 / 79	132 / 83
25 to 29 years	109 / 76	121 / 80	133 / 84
30 to 34 years	110 / 77	122 / 81	134 / 85
35 to 39 years	111 / 78	123 / 82	135 / 86
40 to 44 years	112 / 79	125 / 83	137 / 87
45 to 49 years	115 / 80	127 / 84	139 / 88
50 to 54 years	116 / 81	129 / 85	142 / 89
55 to 59 years	118 / 82	131 / 86	144 / 90
60 to 64 years	121 / 83	134 / 87	147 / 91

In addition to altering your blood pressure and heart rate, exercise can also affect homeostasis by changing your body temperature. As your body moves, the demand for energy increases—therefore cellular respiration will increase, that means that more oxygen will be needed to metabolize sugar for energy. The chemical reaction produces heat—heat that can be dangerous for your body. Your body has counter measures to keep it from overheating and will attempt to lower body temperature.



The class will be divided into three large groups. Within each group—students will either be a researcher or test subject.

Heart Rate Researcher: responsible for measuring and collecting the heart rate of all test subjects

Blood Pressure Researcher: responsible for measuring and collecting the blood pressure of all test subjects

Temperature Researcher: responsible for measuring and collecting the body temperature of all test subjects

Time Management Researcher: responsible for making sure each researcher/test subject is taking data points at the correct time.

Test Subjects: Should vary in their cardiovascular strength (minimum of 3 test subjects per group)

<u>Your Task!</u>

1. Using the science inquiry lab report—make a hypothesis regarding which of your test subjects will be able to maintain/recover into homeostasis based on the background material provided and personal history of test subjects.

2. Material: Each group will be given a temperature laser gun and automatic blood pressure cuff which measure BP and Pulse.

3. Procedure—creates a procedure to measure baseline data, exercise data and post exercise data for all of your test subjects. Remember that science demands multiple data points and you will need to time out when you collect data so that each test subject is able to maintain sustained exercise totaling at least 15 minutes, which can be broken into shorter segments to take blood pressure/temperature. Remember you only have 1 BP cuff and temperature gun, you will need to create a schedule for all of your researchers and test subjects to maintain and put someone in charge of coordinating this task.

4. Create a data table before the day of the lab so you can easily input the data as you collect it. You will need to collect data for each test subject, multiple times for each metric: heart rate (pulse), blood pressure and temperature.

5. Graph the data table(s) on graph paper or excel (preferred). You will need to determine what type of graph is most appropriate for your data points. Make sure to use patterns or color to differentiate between test subjects.

6. Based on the evidence you collected—was your hypothesis supported or not supported? Answer analysis questions on Science Lab Format.

The group may collaborate on all parts except the graphs and analysis—that must be the students' own work.