

## LAB 1: ENDOCRINE SYSTEM

### ACTIVITY 1: ENDOCRINE SYSTEM ANATOMY

Use the models to locate the parts of the endocrine system. Provide a hormone for each organ or structure.

\* Denote “**left**” or “**right**” for these structures.

**Chart 1: Endocrine Hormones**

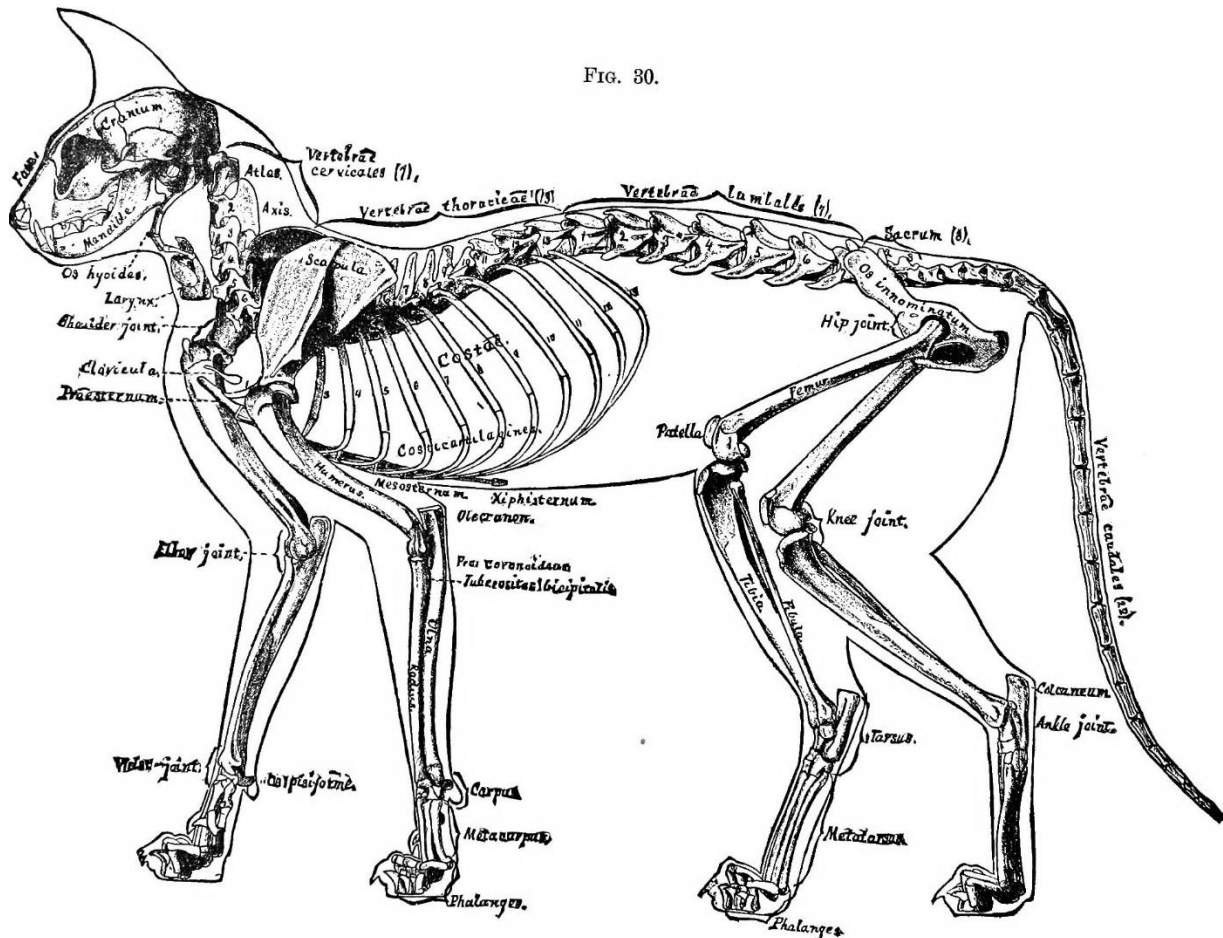
Endocrine System Organ or Structure	Hormone
1. Brain: Hypothalamus	<b>Inhibiting Hormones</b> —example: Prolactin Inhibiting Hormone <b>Releasing Hormones</b> —example: Adrenocorticotropin Releasing Hormone
2. Brain: Pineal gland	Melatonin
3. Pituitary gland	<b>Anterior Pituitary:</b> Thyroid Stimulating Hormone (TSH), Adrenocorticotrophic Hormone (ACTH), Luteinizing Hormone (LH), Follicle Stimulating Hormone (FSH), Prolactin (PRO), and Growth Hormone (GH) <b>Posterior Pituitary:</b> Antidiuretic Hormone (ADH) and Oxytocin (OXY) [both hormones produced by the hypothalamus and released by Posterior Pituitary]
4. Thyroid gland	Thyroid Hormone
Thymus	Thymosin
5. Pancreas	Insulin, Glucagon
6. Duodenum	Gastrin, Secretin, Cholecystokinin (CCK)
7. Adrenal glands*	Adrenal Cortex: Aldosterone, Cortisol, Androgens Adrenal Medulla: Epinephrine (EPI) and Norepinephrine (NE)
8. Kidney*	Erythropoietin (EPO)
9. Ovary*	Estrogen, Progesterone
10. Testes*	Testosterone
11. Placenta	Human Chorionic Gonadotropin (hCG)
12. Heart	Atrial natriuretic peptide (ANP)

## LAB 1: ENDOCRINE SYSTEM

### ACTIVITY 2: CAT DISSECTION FOR ENDOCRINE GLANDS

*Locate these endocrine glands on the images of the dissected cat:*

1. Thyroid Gland {around the larynx}
2. Thymus
3. Heart
4. Adrenal Glands (left and right) {found between the kidneys closer to the aorta and IVC}
5. Kidneys (left and right)
6. Duodenum
7. Pancreas {posterior to stomach}
8. Ovaries (left and right)
9. Testes (no need for left or right)



## LAB 1: ENDOCRINE SYSTEM

### ACTIVITY 3: ENDOCRINE SYSTEM PHYSIOLOGY

#### Pre-Lab Help! How to Calculate Basal Metabolic Rate (BMR)

**Step 1: Conversion of minutes to hours** (60 minutes = 1 hour). The amount of oxygen used in 1 minute will be given. Take the amount of oxygen used and multiply it by 60 to yield the amount of oxygen used in 1 hour.

**Example:** If 7 ml of oxygen were used in 1 minute, then  $60 \text{ min/hr.} \times 7 \text{ ml} = 420 \text{ ml}$  of oxygen will be used in 1 hour.

**Step 2: Conversion of grams to kilograms** (1000 g = 1 kg). The mass of the animal will be given in grams. Take the mass in grams and divide it by 1000 to convert the grams to kilograms.

**Example:** If the rat weighs 333 grams, then  $333 \text{ g} / 1000 \text{ g/kg} = 0.333 \text{ kg}$ .

**Step 3: Calculation of the BMR:** Divide the amount of oxygen used by the weight. Do not flip this one!

**Example:**  $420 \text{ ml oxygen/hr.} / 0.333 \text{ kg} = 1261 \text{ ml oxygen/hr./kg.}$

Upon completion, you should be able to explain the role of thyroxine and the effects of thyroid-stimulating hormone on an animal's metabolic rate. You should be able to predict the metabolic rate of the rat after its injection with propylthiouracil, PTU (a chemical that inhibits thyroxine production).

You will begin with oxygen use for a normal rat, then continue on to measure oxygen use in a thyroidectomized (*Tx*) (thyroid removed) rat and a hypophysectomized (*hypox*) (pituitary gland removed) rat. We will first predict anticipated results in the table below.

#### Basal Metabolic Rate (BMR) Ranges

Below 1700 mL O<sub>2</sub>/kg/hr. = Below normal

1700-1800 mL O<sub>2</sub>/kg/hr. = Normal

Above 1800 mL O<sub>2</sub>/kg/hr. = Above normal

**Step 1:** After reviewing the functions of TH, TSH, and PTU with your instructor. Predict the consequences of the experiments listed in Chart 2 below.

**Chart 2: BMR Predictions**

	Type of Rat		
	Normal	Lacking Thyroid	Lacking Pituitary
No Treatment			
Receives TH			
Receives TSH			
Receives PTU			

**Step 2:** Once your predictions are made in **Chart 2**, calculate the BMR's for each rat in Chart 3. Compare your predictions from Chart 2 to your calculations from Chart 3. Then answer the questions that follow.

## LAB 1: ENDOCRINE SYSTEM

### ACTIVITY 3: ENDOCRINE SYSTEM PHYSIOLOGY, continued

**Chart 3: Effects of Hormones on Metabolic Rate**

As your instructor guides you through this activity, complete this chart: Round numbers to a whole number

	Normal Rat	Thyroidectomized Rat	Hypophysectomized Rat
<i>Baseline</i>			
<b>mL O<sub>2</sub> used in 1 minute</b>	7.1 mL	6.2 mL	6.1 mL
<b>mL O<sub>2</sub> used per hour</b>	_____ mL	_____ mL	_____ mL
<b>Weight</b>	244 g = _____ kg	264 g = _____ kg	266 g = _____ kg
<b>Row 1: Metabolic rate</b>	_____ mL O <sub>2</sub> /kg/hr	_____ mL O <sub>2</sub> /kg/hr	_____ mL O <sub>2</sub> /kg/hr
<i>With Thyroxine (TH)</i>			
<b>mL O<sub>2</sub> used in 1 minute</b>	7.4 mL	7.5 mL	7.6 mL
<b>mL O<sub>2</sub> used per hour</b>	_____ mL	_____ mL	_____ mL
<b>Weight</b>	234 g = _____ kg	255 g = _____ kg	266 g = _____ kg
<b>Row 2: Metabolic rate</b>	_____ mL O <sub>2</sub> /kg/hr	_____ mL O <sub>2</sub> /kg/hr	_____ mL O <sub>2</sub> /kg/hr
<i>With Thyroid Stimulating Hormone (TSH)</i>			
<b>mL O<sub>2</sub> used in 1 minute</b>	7.8 mL	6.0 mL	7.6 mL
<b>mL O<sub>2</sub> used per hour</b>	_____ mL	_____ mL	_____ mL
<b>Weight</b>	243 g = _____ kg	273 g = _____ kg	257 g = _____ kg
<b>Row 3: Metabolic rate</b>	_____ mL O <sub>2</sub> /kg/hr	_____ mL O <sub>2</sub> /kg/hr	_____ mL O <sub>2</sub> /kg/hr
<i>With Propylthiouracil (PTU)</i>			
<b>mL O<sub>2</sub> used in 1 minute</b>	6.1 mL	6.1 mL	6.1 mL
<b>mL O<sub>2</sub> used per hour</b>	_____ mL	_____ mL	_____ mL
<b>Weight</b>	265 g = _____ kg	262 g = _____ kg	249 g = _____ kg
<b>Row 4: Metabolic rate</b>	_____ mL O <sub>2</sub> /kg/hr	_____ mL O <sub>2</sub> /kg/hr	_____ mL O <sub>2</sub> /kg/hr

## LAB 1: ENDOCRINE SYSTEM

### ACTIVITY 3: ENDOCRINE SYSTEM PHYSIOLOGY, continued

#### Activity 1 Determine Baseline Metabolic Rates Questions

(Compare metabolic rates of rats in Row 1, using Chart 3 on previous page)

1. Which rat had the fastest metabolic rate? \_\_\_\_\_
- 2a. What happened to the BMR of the thyroidectomized rat as compared to the normal rat? \_\_\_\_\_  
\_\_\_\_\_
- 2b. Explain why the BMR changed in the thyroidectomized rat. \_\_\_\_\_
- 3a. What happened to the BMR of the hypophysectomized rat as compared to the normal rat? \_\_\_\_\_  
\_\_\_\_\_
- 3b. Explain why the BMR changed in the hypophysectomized rat. \_\_\_\_\_

#### Activity 2: Determine Metabolic Rates after Thyroxine Injection Questions

(Compare metabolic rates of rats in Row 2)

- 4a. Did the BMR of the normal rat drop below normal, normalize, or increase above normal after it received TH? \_\_\_\_\_  
\_\_\_\_\_
- 4b. Explain your results. \_\_\_\_\_
- 5a. Did the BMR of the thyroidectomized rat drop below normal, normalize, or increase above normal after it received TH? \_\_\_\_\_
- 5b. Explain your results. \_\_\_\_\_
- 6a. Did the BMR of the hypophysectomized rat drop below normal, normalize, or increase above normal after it received TH? \_\_\_\_\_
- 6b. Explain your results. \_\_\_\_\_

#### Activity 3: Determine Metabolic Rates after TSH Injection Questions

(Compare metabolic rates rats in Row 3)

- 7a. What happened to the BMR of the normal rat after it received TSH? \_\_\_\_\_
- 7b. Explain why the BMR changed after the normal rat received TSH \_\_\_\_\_  
\_\_\_\_\_
- 8a. What happened to the BMR of the thyroidectomized rat after it received TSH? \_\_\_\_\_
- 8b. Explain why the BMR changed after the thyroidectomized rat received TSH. \_\_\_\_\_  
\_\_\_\_\_
- 9a. What happened to the BMR of the hypophysectomized rat after it received TSH? \_\_\_\_\_
- 9b. Explain why the BMR changed after the hypophysectomized rat received TSH. \_\_\_\_\_  
\_\_\_\_\_
10. Did the results for the thyroidectomized rat indicate *hyperthyroidism* or *hypothyroidism*? \_\_\_\_\_

## LAB 1: ENDOCRINE SYSTEM

### ACTIVITY 3: ENDOCRINE SYSTEM PHYSIOLOGY, continued

#### Activity 4: Determine Metabolic Rates after PTU Injection Questions

(Compare metabolic rates of rats in Row 4)

11a. Did the BMR of the normal rat stay below normal or did it go below normal after it received PTU? \_\_\_\_\_

11b. Explain why the BMR changed after the normal rat received PTU. \_\_\_\_\_

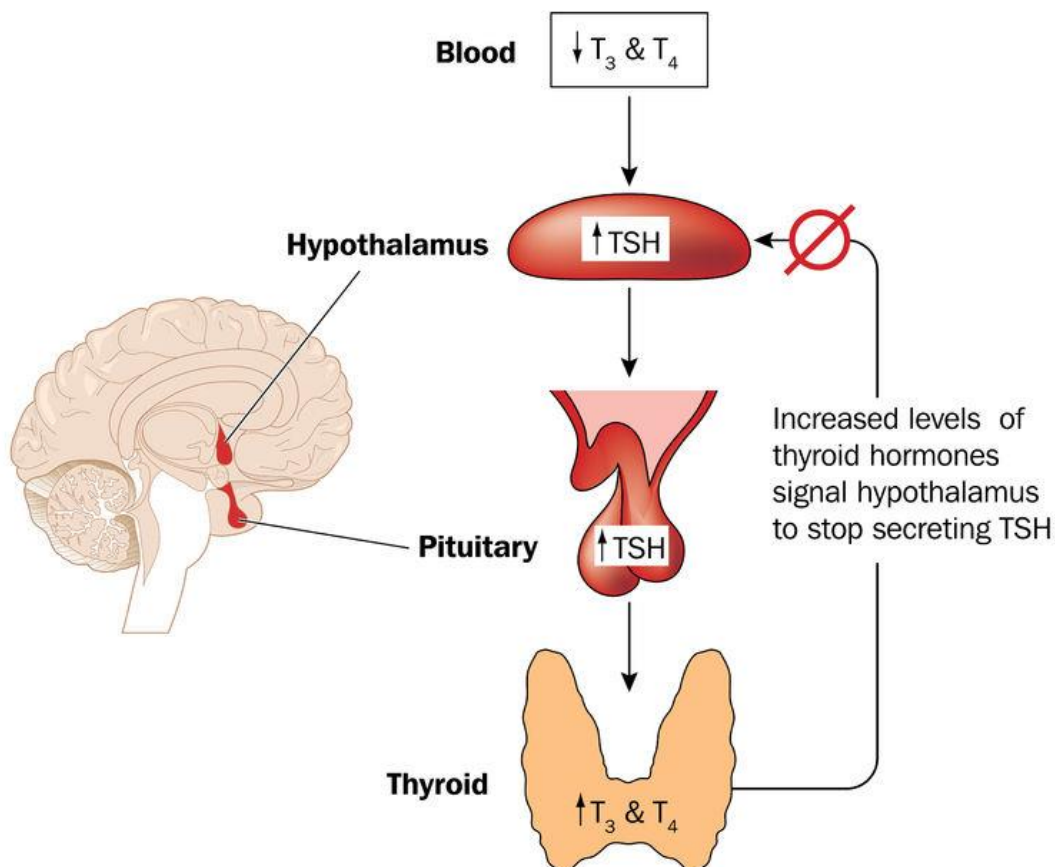
12a. Did the BMR of the thyroidectomized rat stay below normal or did it go below normal after it received PTU? \_\_\_\_\_

12b. Explain why the BMR changed after the thyroidectomized rat received PTU. \_\_\_\_\_

13a. Did the BMR of the hypophysectomized rat stay below normal or did it go below normal after it received PTU? \_\_\_\_\_

13b. Explain why the BMR changed after the hypophysectomized rat received PTU. \_\_\_\_\_

14. Do you think the drug propylthiouracil is used to treat hyperthyroidism or hypothyroidism? Explain your answer. \_\_\_\_\_



## LAB 1: ENDOCRINE SYSTEM

### ACTIVITY 4: BMR & BMI

#### 1. Metabolism

Various chemical compounds are held together by different chemical bonds. When we eat these compounds, the bonds are broken and reformed. During this process, energy is released. The amount of released energy is measured in calories. A **calorie** is the amount of heat needed to raise the temperature of 1 gram of water by 1 Celsius degree. When nutritionists refer to the calories in food, they are actually using kilocalories (C), 1000 calories.

Even though metabolism is defined as all the chemical reactions occurring in a cell or body, when we are measuring the metabolic rate of someone, we are really only measuring the catabolic reactions in which nutrients are broken down to release chemical energy for the sake of performing work in the body.

The **basal metabolic rate (BMR)** is the minimal caloric requirement needed to sustain life in a resting individual. This is the amount of energy your body would burn if you slept all day – 24 hours. There are many factors that will affect your BMR.

What will *increase* BMR? Increased activity, height, stress, fever, decreased environmental temperature

What will *decrease* BMR? Increased age, fat, malnutrition

#### 2. Body Mass Index (BMI)

If the calorie input is greater than the body's needs, the excess compounds tend to be converted to fat. The following table shows the average percent body weight from specific tissues.

Besides your diet and gender, other factors that contribute to these ratios are your fitness level, age and body size. Body size is calculated as the **body mass index (BMI)**, which uses a formula to calculate the balance between your height and weight.

**LAB 1: ENDOCRINE SYSTEM**  
**ACTIVITY 4: BMR & BMI, continued**  
*BMR Practice Problems*

1. Calculate BMR given:

A 347-gram rat used 8.3 mL oxygen in 1 minute

2. Calculate BMR given:

A 453-gram rat used 7.2 mL oxygen in 1 minute

3. Calculate BMR given:

A 222-gram rat used 9.7 mL oxygen in 1 minute



## LAB 1: ENDOCRINE SYSTEM

### ACTIVITY 4: BMR & BMI, continued

#### *Answers to BMR Practice Problems from Previous Page*

1. Calculate BMR given: A 347-gram rat used 8.3 mL oxygen in 1 minute
  - a. Convert grams to kilograms.  $347\text{g}/1000\text{ g/kg} = 0.347\text{ kg}$
  - b. Convert volume/min to volume/hr.  $8.3\text{ mL/min} \times 60\text{ min/hr} = 498\text{ mL oxygen/hr}$
  - c. Calculate the BMR:  $498\text{ mL oxygen/hr}/0.347\text{ kg} = \mathbf{1435\text{ mL oxygen/hr/kg}}$
  
2. Calculate BMR given: A 453-gram rat used 7.2 mL oxygen in 1 minute
  - a. Convert grams to kilograms.  $453\text{g}/1000\text{ g/kg} = 0.453\text{ kg}$
  - b. Convert volume/min to volume/hr.  $8.3\text{ mL/min} \times 60\text{ min/hr} = 432\text{ mL oxygen/hr}$
  - c. Calculate the BMR:  $432\text{ mL oxygen/hr}/0.453\text{ kg} = \mathbf{954\text{ mL oxygen/hr/kg}}$
  
3. Calculate BMR given: A 222-gram rat used 9.7 mL oxygen in 1 minute
  - a. Convert grams to kilograms.  $222\text{g}/1000\text{ g/kg} = 0.222\text{ kg}$
  - b. Convert volume/min to volume/hr.  $9.7\text{ mL/min} \times 60\text{ min/hr} = 582\text{ mL oxygen/hr}$
  - c. Calculate the BMR:  $582\text{ mL oxygen/hr}/0.222\text{ kg} = \mathbf{2622\text{ mL oxygen/hr/kg}}$

*(Honorlock allows the use of a calculator; you will be able to use the calculator provided on the lab test to complete these calculations...you'll just need to remember the formula to use.)*