PhysioEx Lab Report

Exercise 4: Endocrine System Physiology

Activity 1: Metabolism and Thyroid Hormone

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Pre-lab Quiz Results

You scored 100% by answering 6 out of 6 questions correctly.

1. Which of the following statements about metabolism is *false*?

   You correctly answered: All of the energy from metabolism is ultimately stored in the chemical bonds of ATP.

2. Thyroxine is

   You correctly answered: the most important hormone for maintaining the metabolic rate and body temperature.

3. Thyroid-stimulating hormone (TSH) is

   You correctly answered: produced in the pituitary gland.

4. An injection of TSH to an otherwise normal animal will cause which of the following?

   You correctly answered: goiter development.

5. Thyrotropin-releasing hormone (TRH) is

   You correctly answered: secreted by the hypothalamus.

6. Which of the following statements is true?

   You correctly answered: The hypothalamus primarily secretes tropic hormones that stimulate the secretion of other hormones.

Experiment Results

Predict Questions

1. Predict Question 1: Make a prediction about the basal metabolic rate (BMR) of the remaining rats compared with the BMR of the normal rat you just measured.

Your answer: The BMR of both remaining rats will be lower than the normal rat's BMR.

2 Predict Question 2: What do you think will happen after you inject thyroxine into the three rats?

Your answer: The normal rat will become hyperthyroidic and develop a goiter.

3 Predict Question 3: What do you think will happen after you inject TSH into the three rats?

Your answer: The normal rat will become hyperthyroidic and develop a goiter.

4 Predict Question 4: Propylthiouracil (PTU) is a drug that inhibits the production of thyroxine by blocking the attachment of iodine to tyrosine residues in the follicle cells of the thyroid gland (iodinated tyrosines are linked together to form thyroxine). What do you think will happen after you inject PTU into the three rats?

Your answer: The normal rat will become hypothyroidic and develop a goiter.

Stop & Think Questions

1 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 426 ml O_2/hr.

2 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 106.5 ml O_2/kg/hr.

3 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 372 ml O_2/hr.

4 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 91.512 ml O_2/kg/hr.

5 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 378 ml O_2/hr.

6 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 92.232 ml O_2/kg/hr.

7 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800).

The normal rat is

You correctly answered: euthyroid.

8 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800).

The thyroidectomized (Tx) rat is

You correctly answered: hypothyroid.

9 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800).

The hypophysectomized (Hypox) rat is

You correctly answered: hypothyroid.

10 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 510 ml O_2/hr.

11 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 127.5 ml O_2/kg/hr.

12 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 468 ml O_2/hr.

13 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 115.128 ml O_2/kg/hr.

14 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 468 ml O_2/hr.

15 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 114.192 ml O_2/kg/hr.

16 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800) after the thyroxine injection.

The normal rat is

Your answer: euthyroid.

Correct answer: hyperthyroid.

17 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800) after the thyroxine injection.

The thyroidectomized (Tx) rat is

Your answer: hypothyroid.

Correct answer: hyperthyroid.

18 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800) after the

thyroxine injection.

The hypophysectomized (Hypox) rat is

You correctly answered: hyperthyroid.

19 Which of the rats developed a goiter after injection with thyroxine?

Your answer: the thyroidectomized rat.

Correct answer: None of the rats developed a goiter with this injection.

20 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 480 ml O_2/hr.

21 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 120 ml O_2/kg/hr.

22 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 378 ml O_2/hr.

23 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 92.988 ml O_2/kg/hr.

24 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 468 ml O_2/hr.

25 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 114.192 ml O_2/kg/hr.

26 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800) after the TSH injection.

The normal rat is

You correctly answered: hyperthyroid.

27 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800) after the TSH injection.

The thyroidectomized (Tx) rat is

You correctly answered: hypothyroid.

28 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid

levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800) after the TSH injection.

The hypophysectomized (Hypox) rat is

Your answer: euthyroid.

Correct answer: hyperthyroid.

29 Which of the rats did not develop a goiter after injection with TSH?

You correctly answered: the thyroidectomized rat.

30 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 372 ml O_2/hr.

31 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 93 ml O_2/kg/hr.

32 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 378 ml O_2/hr.

33 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 92.988 ml O_2/kg/hr.

34 Calculate the oxygen consumption per hour for this rat using the following equation.

ml O_2 consumed/1 minute x 60 minutes/hour = ml O_2/hour

Enter the oxygen consumption per hour.

You answered: 92.988 ml O_2/hr.

35 Now that you have calculated the oxygen consumption per hour for this rat, you can calculate the metabolic rate per kilogram of body weight with the following equation (note that you need to convert the weight data from grams to kilograms to use this equation).

Metabolic rate = (ml O_2/hr)/(weight in kg) = ml O_2/kg/hr

Enter the metabolic rate.

You answered: 92.988 ml O_2/kg/hr.

36 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800) after the PTU injection.

The normal rat is

You correctly answered: hypothyroid.

37 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800) after the PTU injection.

The thyroidectomized (Tx) rat is

You correctly answered: hypothyroid.

38 Judging from their basal metabolic rates (an indicator of thyroid function), categorize the rats as hypothyroid (low thyroid levels; BMR below 1600), euthyroid ("good," or normal, thyroid

levels; BMR = 1650-1750), or hyperthyroid (high thyroid levels; BMR above 1800) after the PTU injection.

The hypophysectomized (Hypox) rat is

You correctly answered: hypothyroid.

39 Which of the rats developed a goiter after injection with PTU?

You correctly answered: the normal rat.

Experiment Data

Rat	Weight (g)	ml O_2/min	ml O_2/hr	BMR (ml O_2/kg/hr)	Palpation	Injected
Normal	250	7.1	426.00	1704.00	No Mass	none
Tx	246	6.2	372.00	1512.20	No Mass	none
Hypox	244	6.3	378.00	1549.18	No Mass	none
Normal	250	8.5	510.00	2040.00	No Mass	thyroxine
Tx	246	7.8	468.00	1902.44	No Mass	thyroxine
Hypox	244	7.8	468.00	1918.03	No Mass	thyroxine
Normal	250	8.0	480.00	1920.00	Mass	TSH
Tx	246	6.3	378.00	1536.59	No Mass	TSH
Hypox	244	7.8	468.00	1918.03	Mass	TSH
Normal	250	6.2	372.00	1488.00	Mass	PTU
Tx	246	6.3	378.00	1536.59	No Mass	PTU
Hypox	244	6.4	384.00	1573.77	No Mass	PTU

Post-lab Quiz Results

You scored 100% by answering 7 out of 7 questions correctly.

1 How would you treat a thyroidectomized animal so that it functions like a "normal" animal?

You correctly answered: Provide the animal T_4 supplements.

2 As a result of the missing hormone(s) in the hypophysectomized rat, what would be an expected symptom?

You correctly answered: decreased basal metabolic rate.

3 An injection of thyroxine to an otherwise normal rat will cause which of the following?

You correctly answered: hyperthyroidism.

4 Why didn't any of the rats develop a goiter after thyroxine injection?

You correctly answered: In all cases, TSH levels were not elevated by the thyroxine injection.

5 Why did the normal rat develop a palpable goiter with the TSH injection?

You correctly answered: The TSH receptors on the thyroid gland were excessively stimulated.

6 An injection of propylthiouracil to an otherwise normal animal will cause which of the following?

You correctly answered: goiter development.

7 Why did the normal rat develop a palpable goiter with the propylthiouracil injection?

You correctly answered: The injection decreased the negative feedback mechanism on TSH.

Review Sheet Results

1 **Part 1: Determining the Basal Metabolic Rates**

Which rat had the fastest basal metabolic rate (BMR)?

Your answer:

The normal rat in all trails except for the injections of PTU.

2 Why did the metabolic rates differ between the normal rat and the surgically altered rats? How well did the results compare with your prediction?

Your answer:

The results of the experiment confirm my hypothesis.

3 If an animal has been thyroidectomized, what hormone(s) would be missing in its blood?

Your answer:

Thyroxine and triiodothyronine which are both hormones created by the thyroid gland.

4 If an animal has been hypophysectomized, what effect would you expect to observe in the hormone levels in its body?

Your answer:

The TSH levels and thyroxine would be missing or dramatically low. Which means that the thyroid gland is not getting stimulated by the pituitary gland to create thyroxine.

5 **Part 2: Determining the Effect of Thyroxine on Metabolic Rate**

What was the effect of thyroxine injections on the normal rat's BMR?

Your answer:

It was increased by a sustainable amount; thus the results of the experiment confirm my hypothesis.

6 What was the effect of thyroxine injections on the thyroidectomized rat's BMR? How does the BMR in this case compare with the normal rat's BMR? Was the dose of thyroxine in the syringe too large, too small, or just right?

Your answer:

It increased the BMR of all the rats, the difference is around 120mL/O2/kg/hr. The dose wa high.

7 What was the effect of thyroxine injections on the hypophysectomized rat's BMR? How does the BMR in this case compare with the normal rat's BMR? Was the dose of thyroxine in the syringe too large, too small, or just right?

Your answer:

It increased the BMR of all the rats, the difference is around 120mL/O2/kg/hr. The dose was high.

8 **Part 3: Determining the Effect of TSH on Metabolic Rate**

What was the effect of thyroid-stimulating hormone (TSH) injections on the normal rat's BMR?

Your answer:

It increased BMR dramatically.

9 What was the effect of TSH injections on the thyroidectomized rat's BMR? How does the BMR in this case compare with the normal rat's BMR? Why was this effect observed?

Your answer:

It lowered that rat's BMR into a hyperthyroidic state and the BMR was down into the 1500's.

10 What was the effect of TSH injections on the hypophysectomized rat's BMR? How does the BMR in this case compare with the normal rat's BMR? Was the dose of TSH in the syringe too large, too small, or just right?

Your answer:

This increase the Hypox rat's BMR into a hyperthyroidic range, The dose was too high, and it was close to the BMR of the normal rate at this point.

11 **Part 4: Determining the Effect of Propylthiouracil on Metabolic Rate**

What was the effect of propylthiouracil (PTU) injections on the normal rat's BMR? Why did this rat develop a palpable goiter?

Your answer:

It inhibited the production of TSH causing the thyroid gland to not create enough thyroxin

12 What was the effect of PTU injections on the thyroidectomized rat's BMR? How does the BMR in this case compare with the normal rat's BMR? Why was this effect observed?

Your answer:

It lowered the BMR into a hyperthyroidic range and was relatively even with the BMR from the normal rat.

13 What was the effect of PTU injections on the hypophysectomized rat's BMR? How does the BMR in this case compare with the normal rat's BMR? Why was this effect observed?

Your answer:

It lowered the BMR into a hyperthyroidic range and was relatively even with the BMR from the normal rat.