

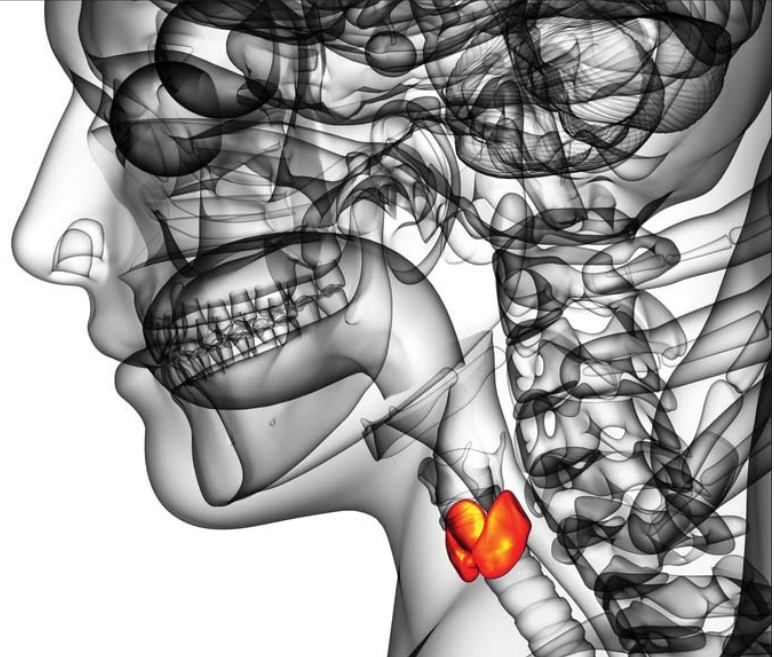
Thyroid Troubles: A Case Study in Negative Feedback Regulation

by

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Part I – Initial Office Visit

You are six months into a year-long internship at Dr. Mara Siddiqui's endocrinology clinic. So far, you've had a great experience with Dr. Siddiqui and you've seen patients with a wide range of endocrine issues. Today, you will shadow Dr. Siddiqui as she examines Angela Barber, a patient who was referred by her primary care physician. While waiting, you pull up Angela's information on the computer and you find that she is a 52-year-old African American woman. Except for not feeling like herself over the last three months, she has no health issues.

Angela arrives at the clinic and you accompany the nurse to the exam room to get Angela's vitals. Dr. Siddiqui comes into the exam room and asks Angela what has been bothering her. Angela tells the doctor that she has been cold, tired, fatigued, and just not feeling up to her normal activities. She has also gained roughly 20 pounds, even though she has been consciously monitoring her food intake. Angela can't understand what is wrong—she went through menopause a year ago but she insists that the way she is feeling is not related to that change; she also has not changed anything else about her normal routine. Dr. Siddiqui listens to Angela and then examines her ears, eyes, and throat; she also listens to Angela's lungs and heart, and palpates her neck and abdomen. All of Angela's vitals and the outcome of the initial exam are within normal range. Dr. Siddiqui tells Angela that she suspects a thyroid issue and would like to order some blood tests.

Angela asks about the thyroid and why it is important. Dr. Siddiqui asks you to help explain this hormone system to the patient.

Questions

1. Diagram the hypothalamic-pituitary-thyroid axis. Make sure to include the feedback loops and spell out the hormone names.
2. What is the physiological role of thyroid hormones? Does T_3 or T_4 play a larger role on the target tissues? Explain.

Part II – Research

Dr. Siddiqui tells Angela that her test results will be back in a few days and that she will give her a call when she knows something. You go home and do some research on various thyroid conditions so that you'll have a good idea of what is going on with Angela. You find information on hyperthyroidism, hypothyroidism, goiter, Graves' Disease, iodine deficiency (primary hypothyroidism), Hashimoto's thyroiditis, and various tumors. You make a chart to help yourself sort out the different disorders.

Questions

- Describe hyperthyroidism and hypothyroidism. List at least three symptoms of each.
- What is a goiter?
- Please fill out the chart below. Record whether the hormone levels are expected to be high, low, or either. For antibody/immunoglobulins and goiter, answer yes, no, or possible. (The antibodies and immunoglobulins in question are those specific to the thyroid disorder.)

	<i>Primary hypothyroidism (iodine deficiency)</i>	<i>Graves' Disease</i>	<i>Hashimoto's Disease</i>	<i>TRH-secreting tumor</i>	<i>TSH-secreting tumor</i>	<i>TRH-suppressing tumor</i>	<i>TSH-suppressing tumor</i>
<i>TRH levels</i>							
<i>TSH levels</i>							
<i>T₃ and T₄ levels</i>							
<i>Antibodies or immunoglobulins present?</i>							
<i>Goiter present?</i>							
<i>Is patient hyper- or hypothyroid?</i>							

- Use the chart below to record whether the hormone levels are expected to be high, low, or either. For antibody/immunoglobulin and goiter, answer yes, no, or possible.

	<i>Hypothyroidism</i>	<i>Hyperthyroidism</i>
<i>TSH levels</i>		
<i>T₃ and T₄ levels</i>		
<i>Antibodies or immunoglobulins?</i>		
<i>Goiter present?</i>		

- If you gave a person with primary hypothyroidism (iodine deficiency) an injection of TSH would T₃ and T₄ levels increase? Why or why not?
- Some patients with HPT axis problems develop a goiter. Describe two different scenarios/conditions in which a goiter would be present and explain physiologically why/how the goiter occurs within each scenario/condition. Make sure to include axis feedback in your answer.

Part III – Test Results

Angela's test results come back and Dr. Siddiqui gives you a copy to look over. Please use the data below and the initial information about Angela to answer the following questions.

A. Barber – Test Results

<i>Test</i>	<i>Result</i>	<i>Normal Range</i>
<i>Serum thyroxine (T₄) (ug/dl)</i>	1.8	4.6-12
<i>Thyrotropin (TSH) (μIU/mL)</i>	0.3	0.5-6
<i>TPO and Tg antibodies</i>	Normal	Normal
<i>TSI (immunoglobulins)</i>	Normal	Normal
<i>Serum Triiodothyronine (T3) (ng/dl)</i>	57	80-180
<i>Blood Pressure</i>	98/60	90-120/60-80
<i>Hematocrit (%)</i>	39	36-45
<i>Hemoglobin (g/100 ml blood)</i>	12.9	11-14
<i>Glucose (mg/dl)</i>	102	70-110
<i>Sodium (mmol/L)</i>	136	135-145
<i>Potassium (mmol/L)</i>	4.5	3.5-5.0

Questions

- Are any of Angela's values outside the normal range? If so, which ones, and are they high or low?
- Is Angela's thyroid axis functioning properly? If not, does she have symptoms consistent with hypothyroidism or hyperthyroidism?

Part V – Further Tests

Dr. Siddiqui calls Angela and asks her to come back to the clinic to discuss her results. It appears that Angela has a hormone-suppressing tumor in either the hypothalamus or anterior pituitary. Dr. Siddiqui wants to do some tests to confirm a tumor and determine where the tumor is located. Dr. Siddiqui recommends that Angela go for an MRI, a CAT scan or a PET scan to see if a tumor is visible. She also recommends a TRH challenge test.

Questions

13. Knowing what you do about the HPT axis, what hormonal information would you need to determine if the hormone-suppressing tumor is in the hypothalamus or anterior pituitary? Why is it near impossible to get this information?

14. Dr. Siddiqui injects Angela with a dose of TRH and draws a blood sample to measure TSH and thyroid hormone levels. What results would you expect if the tumor is in the hypothalamus? The anterior pituitary? Use the table below to organize your answers (state high or low) and then explain your rationale for your answer below.

	<i>Hypothalamus tumor</i>	<i>Ant. pituitary tumor</i>
<i>TSH</i>		
<i>Thyroid hormones</i>		

Part VI – Conclusion

The results from Angela's TRH challenge come back and even after injection of TRH her TSH and thyroid hormone levels are low. A MRI scan confirms this diagnosis and shows a tumor on Angela's anterior pituitary. Via biopsy it is determined that this tumor is not cancerous (it is benign) and Dr. Siddiqui decides to treat Angela with thyroid hormone therapy instead of doing a potentially dangerous surgery. Dr. Siddiqui and Angela come up with a treatment plan and they will continue to monitor the state of Angela's pituitary tumor.

