

Researching Type I Diabetes

Peter Judson

peterjudson@mac.com

The Sacred Heart School of Montreal
3635 Atwater Avenue
Montreal, Quebec
Canada, H3H 1Y4

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Mentored by

Ciriaco Piccirillo, Ph.D.
McGill University Health Center
Montreal General Hospital
1650 Cedar Avenue
Room L11.132-144
Montreal, QC H3G 1A4

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TEACHER GUIDE

The following Quebec *Ministry of Education, Leisure, and Sports* (MELS) Competencies for Science and Technology courses are addressed in this unit:

COMPETENCY 1 (C1): Seeks answers or solutions to scientific or technological problems.

COMPETENCY 2 (C2): Makes the most of his/her knowledge of science and technology.

COMPETENCY 3 (C3): Communicates in the languages used in science and technology.

I. Overview

The scientific concepts covered in this unit include the immunoregulation of Type I Diabetes, the use of the non-obese diabetic (NOD) mouse animal model, major structures of the immune system and their dissection, and fundamental flow cytometry concepts. All of these concepts are chosen for instruction as a direct result of the summer laboratory experience in the Piccirillo Immunoregulation Laboratory at McGill University.

There are several lessons in this curriculum unit that can be incorporated into a number of different biology courses from general Biology to A.P. Biology. This unit begins with a roundhouse diagram activity that can be used at the beginning or end of a unit on the immune system or could be added on to an introductory unit on the cell (explaining cell specialization). The roundhouse diagram activity enables the student to demonstrate her understanding of the fundamental concepts regarding the immune system and the immunoregulation of T1D in health and disease. Following this activity the persuasive writing activity allows students to express what they have learned about the NOD mouse as an experimental model in T1D research as well as their understanding of the legal and ethical issues surrounding animal use in basic medical research. The persuasive writing activity can be used in most secondary biology courses, as well as in secondary English courses.

Next, students perform a facile mouse dissection using readily available, formalin preserved mice. The dissection will allow students to learn the location of major lymphatic system structures (spleen, thymus, inguinal lymph gland). The general goal of the mouse dissection is to further develop skills of observation and comparison by studying similarities and differences between human and mouse lymphatic structures.

Additionally, this laboratory activity will build upon prior dissecting experiences to further develop fine-motor skills. Then, the teacher demonstrates flow cytometry using a multi-media, internet-based resource. This activity reinforces the theory learned in the roundhouse diagram component of the unit presented at the beginning of this curriculum unit. Finally, the students synthesize all of the knowledge they acquired in the previous activities via a Web Quest activity. This activity has students explore current clinical and experimental research of T1D and culminates in a cooperative learning project which involves developing and using multimedia presentations (i.e. PowerPoint and Quick Time Video).

II. Science Background

There are two major types of diabetes: Type I Diabetes (T1D), also known as juvenile diabetes, and Type II Diabetes (T2D), the most common form of diabetes. T1D is an immune system disorder in which the body's immune cells attack and destroy insulin-producing cells (beta cells) in the pancreas. T2D is due to the body not producing enough insulin or the body cells do not respond to the insulin. Insulin is a hormone released by cells in the pancreas. It is needed to accelerate the transfer of sugar from the blood into body cells. If you are lacking enough insulin, sugar accumulates in your blood resulting in diabetes. If left untreated, complications such as kidney and heart disease, stroke, blindness, and amputation can result.

The immune system normally protects humans from pathogens such as bacteria and viruses. It also protects us from abnormal or diseased cells such as cancer cells. The immune system allows normal cells and some foreign materials to be tolerated. In health, there is a balance struck between a response to destroy cells and a tolerant (self) response. Autoimmune diseases develop when this balance is upset and the body begins attacking its own tissues.

In the case of T1D the body mistakes the beta cells (insulin producing) of the pancreas as "foreign." The immune response is to produce CD4 and CD8 T cells to collaborate to attack and destroy the beta cells. Additionally, B cells make antibodies against the pancreatic beta cells. It is thought that CD4+Foxp3+ regulatory T cells are integral in regulating this immune response in healthy individuals.

The non-obese diabetic (NOD) strain of mouse spontaneously develops T1D and has proven to be a very useful and important animal in the study of T1D. This mouse strain was developed in Japan by Makino and colleagues while working with cataract-prone mice. At 3-4 months of age the NOD mouse develops T1D with immunological, histological, and metabolic features very comparable to human diabetes. Because the mouse develops diabetes spontaneously it is possible to study the very early stages of the disease before the onset of symptoms.

When studying the immunoregulatory system in T1D there are a number of different cell types that need to be understood. *Beta cells* of the pancreas produce the hormone insulin, T cells (and their subpopulations CD-4, CD-8, Tregs) are immunoregulatory cells that

prevent other immune cells from attacking and destroying the pancreatic beta cells. Dendritic cells are immune system cells that are antigen presenting, in the case of T1D they are thought to be involved in presenting the pancreatic beta cells to CD4+FoxP3- T cells for cell destruction.

As suggested by the name, flow cytometry, makes measurements of cells in a flow system. The cells in a flow cytometer are delivered singly past a light that is focused at the point of measurement. The cells scatter the light and different wavelengths and scattering patterns are recorded and analyzed by flow cytometry software. Cell size, complexity, health, and phenotype are just a few of the parameters that can be measured by this powerful tool. This is especially useful in the study of T1D because of the number of distinct cell populations involved in the disease.

III. Student Outcomes

The content of this unit covers immunoregulation theory in health and disease, immune system structure and function, animal models used in immunology research, and flow cytometry principles and applications in immunology research. The activities employed in this curriculum unit allow students to see and understand the importance of certain research protocols in understanding and finding a cure for T1D.

IV. Learning Objectives

- Students will learn the fundamental concepts of immunology and immunoregulation. Quebec MELS, C1
- Students will analyze arguments for and against the use of animals in medical research. Quebec MELS, C2
- Students will write a persuasive essay expressing their own point of view on using animals in medical research. Quebec MELS, C3
- Students will perform a dissection of the major structures of the mouse immune system. Quebec MELS, C1 and C2
- Students will learn how flow cytometry and cell sorting work and are used in the immunoregulatory studies of T1D. Quebec MELS, C1
- Students will role-play the various roles of individuals involved in the clinical and experimental research of T1D. Quebec MELS, C2
- Students will present their information and data learned in the Web Quest activity to their peers in a PowerPoint format. Quebec MELS, C2 and C3

V. Time Requirements

Total instructional time for this unit is approximately 7 hours (including research done in class). The introductory roundhouse diagram activity is 1 hour. The persuasive writing activity is 1/2 hour in class, with the completion as homework. The mouse dissection is 1 hour (20 minutes of pre-lab work and 40 minutes for the dissection and clean-up). The flow cytometry and cell-sorting demonstration is 1/2 hour. The Web Quest activity is

approximately 3 hours including group work, research done in class, and PowerPoint preparation and presentation.

VI. Advanced Preparation

For the *Roundhouse Diagram* activity photocopy classroom sets of the Roundhouse Diagram template and assessment tool. See Student Section.

For the *Persuasive Writing* activity photocopy classroom sets of the NOD mouse handout and self-assessment rubric. See Student Section.

For the *Mouse Dissection* classroom sets of dissection trays, dissection tool kits, gloves, and preserved mice (available from Boreal-Northwest, product # 67735 M 10, phone no. 800-387-9393) should be assembled prior to the lab. Photocopy classroom sets of the *Mouse Dissection Protocol*.

For the *Flow Cytometry and Cell-Sorting* activity the teacher will need a computer with internet access, browser and an LCD projector to project the animation. The url for this animation is:

http://probes.invitrogen.com/resources/education/tutorials/4Intro_Flow/player.html

For the *Web Quest* activity a computer lab for students is required. The url for this activity is: <http://questgarden.com/index.php>

VII. Materials and Equipment

Preserved Mice, 1 mouse per lab group

Dissection Trays, 1 tray per lab group

Dissection Kit, 1 kit per pair lab group. Each kit should contain scissors, scalpels, dissection pins, and forceps

Latex gloves, 1 pair per student

VIII. Student Prior Knowledge and Skills

Students should have a fundamental understanding of the lymphatic system and immunity. They should have knowledge of the lymph nodes, lymphatic organs, antigen-antibody reactions, non-specific and specific immunity. Students should be familiar with lab safety and basic dissection procedures.

IX. What is Expected from Students

Students are expected to learn fundamental concepts (cell types and interactions) of immunoregulation in normal and diseased (T1D) states. Students will learn about the use of animals in medical research, particularly about the NOD mouse in diabetes research. It is expected that students will learn the location of major lymphatic structures in the mouse and techniques for removal and preparation of these structures for analysis by

flow cytometry. Students should be able to apply their knowledge of immune cell types and immune structures in interpreting basic flow cytometry data.

X. Anticipated Results

Answers to the *Mouse Dissection* Analysis and Conclusion questions and the *Flow Cytometry* post-viewing questions are found in the Science Background Section.

XI. Classroom Discussion

Prior-Knowledge Questions

1. What is the name of the organ that produces insulin?

Answer: The Pancreas

2. What is the role of insulin in the body?

Answer: Insulin regulates the amount of glucose in the blood.

3. What is meant by antigenic specificity?

Answer: The ability of an antibody to distinguish between protein molecules that differ in only a single amino acid.

4. The “fluid-mosaic” model of the cell membrane describes a phospho-lipid bilayer interwoven with what class of bio-molecules?

Answer: Proteins

XII. Assessment

1. The *Roundhouse Diagram* assessment tool is given to the students with the activity instructions. This assessment tool is used by the teacher when grading the diagram.
2. The *Persuasive Writing* rubric is given to the student with the activity instructions. This assessment tool is used by the teacher when grading the diagram.
3. Students should be required to write a laboratory report for *the Mouse Dissection* experiment.
4. A post-viewing quiz of the Flow Cytometry video is optional.

XIII. References

Murphy, K., Travers, P., and Walport, M.: (2008) Janeway's Immunobiology. 7th Ed. New York: Garland Science.

Sakaguchi, S., Yamaguchi, T., Nomura, T., and Ono, M.: Regulatory T Cells and Immune Tolerance. Cell. 2008.05.009.

Chatenoud, L., and Bach, J.F.: Regulatory T Cells in the Control of Autoimmune Diabetes: The Case of the NOD Mouse. International Reviews of Immunology, 24: 247-267, 2005.

Hackney M.W. and Ward, R.E., How-To-Learn Biology via Roundhouse Diagrams, The American Biology Teacher, 64:7: 525-533, 2002.

Yashon, Ronnee., Case Studies in Bioethics, self-published, 2002.

<http://pzweb.harvard.edu/Research/RubricsSelfPE.htm>

http://www.jdrf.org/index.cfm?page_id=101982

<http://icg.cpmc.columbia.edu/cattorette/Protocol/mousepathology/mouseTissue.html>

<http://www.mcgill.ca/researchoffice/compliance/animal/>

<http://webquest.org/index-create.php>

<http://www.informatics.jax.org/cookbook/figures/figure55.shtml>

<http://tvmouse.compmed.ucdavis.edu/virtualnecropsy/>

<http://www.niaid.nih.gov/LabsAndResources/labs/aboutlabs/cmb/InfectiousDiseasePathogenesisSection/mouseNecropsy/Pages/instrumentsFixatives.aspx>

http://en.wikipedia.org/wiki/Flow_cytometry

STUDENT SECTION

I. Rationale

Throughout human history, diabetes has been a leading cause of death by disease. It affects millions of people in one way or another. It could be that you have the disease or know someone, family member or friend, who are suffering from the complications of diabetes.

Type I diabetes (T1D) is an autoimmune disease that results in the insulin-producing beta cells of the pancreas being destroyed. The lack of insulin causes an increase in blood sugar levels and subsequent appearance of glucose in the urine. Sweet urine was the symptom by which the disease was first identified in antiquity. Glucose in the urine or glycosuria causes patients to urinate more frequently and drink more than normal. The frequent urination and excessive thirst were the symptoms that resulted in the discovery of the disease.

T1D is lethal unless treated with insulin. Insulin injection by needle is the most common method for administration, however, indwelling catheters, insulin pumps, insulin inhalers, and other experimental methods are being studied. People with T1D must inject/receive exogenous insulin several times every day.

Currently there is no useful preventive measure against developing T1D. Vaccines have been proposed and are being tested. Most people who develop the disease have not prior health problems and are of healthy weight at the onset of the disease. Rapid and dangerous weight loss, if the disease is not promptly diagnosed and treated can result.

II. Materials

Lesson 1: Roundhouse Diagram Activity

All written materials needed contained within the following Procedures section.

Lesson 2: Persuasive Writing Activity

All written materials needed contained within the following Procedures section

Lesson 3: Mouse Dissection Laboratory Activity

Dissection instructions contained within the following Procedures section. The Mouse and dissection kit is to be obtained from your teacher.

Lesson 4: Flow Cytometry Activity

All written materials needed contained within the following Procedures section

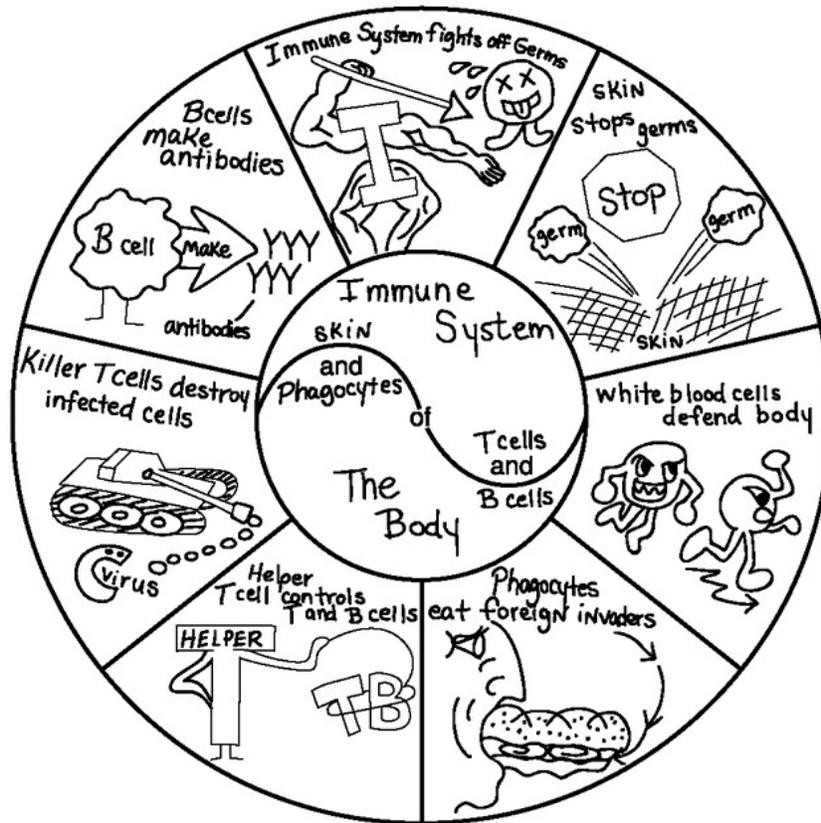
Lesson 5: TID Web Quest

All instructions contained at the following url: <http://questgarden.com/index.php>

III. Procedures

Lesson 1: Roundhouse Diagram Activity

A roundhouse diagram is a learning tool that allows you to reconstruct your ideas about the material you are learning into a word and image diagram. Here is an example:



Goals: I want to understand more about white blood cells and the immune system.

Steps to make a roundhouse diagram

1. Identify the main ideas you are exploring and state your goal below the diagram. Write the goal under the diagram.
2. Create a title for the diagram in the center circle. Use the word “of” in the main title of the diagram. Use the “and” words to break down the title into subordinate concepts.

3. Take your entire concept and break it down into **seven** parts.
4. Take each of your seven parts and **chunk** the information.
5. Draw an image that relates directly to each chunk of information.
6. Evaluate your diagram with the marking provided on page 13 prior to turning it in.

Instructions:

Read the following passage about T1D and then make a roundhouse diagram on the blank template provided. The 7 main parts of the reading have been provided following the passage.

When studying the immunoregulatory system in T1D there are a number of different cell types that need to be understood. Beta cells of the pancreas produce the hormone insulin, T cells (and their subpopulations CD-4, CD-8, Tregs) are immunoregulatory cells that prevent other immune cells from attacking and destroying the pancreatic beta cells. Dendritic cells are immune system cells that are antigen presenting cells, in the case of T1D this means that they are thought to be involved in presenting the pancreatic beta cells to CD4⁺FoxP3⁻ T cells for cell destruction. It is thought that in health that CD4⁺Foxp3⁺ T Cells are protective, that is, they prevent the pancreatic beta cells from being attacked and destroyed by CD4⁺TFoxp3⁻ cells and CD8 T cells.

Pancreatic Beta Cells

CD4⁺Foxp3⁺ T Cells: Protectors

CD8 T Cells. Cytotoxic

B Lymphocytes: Mediator

Dendritic Cells: Antigen Presenters

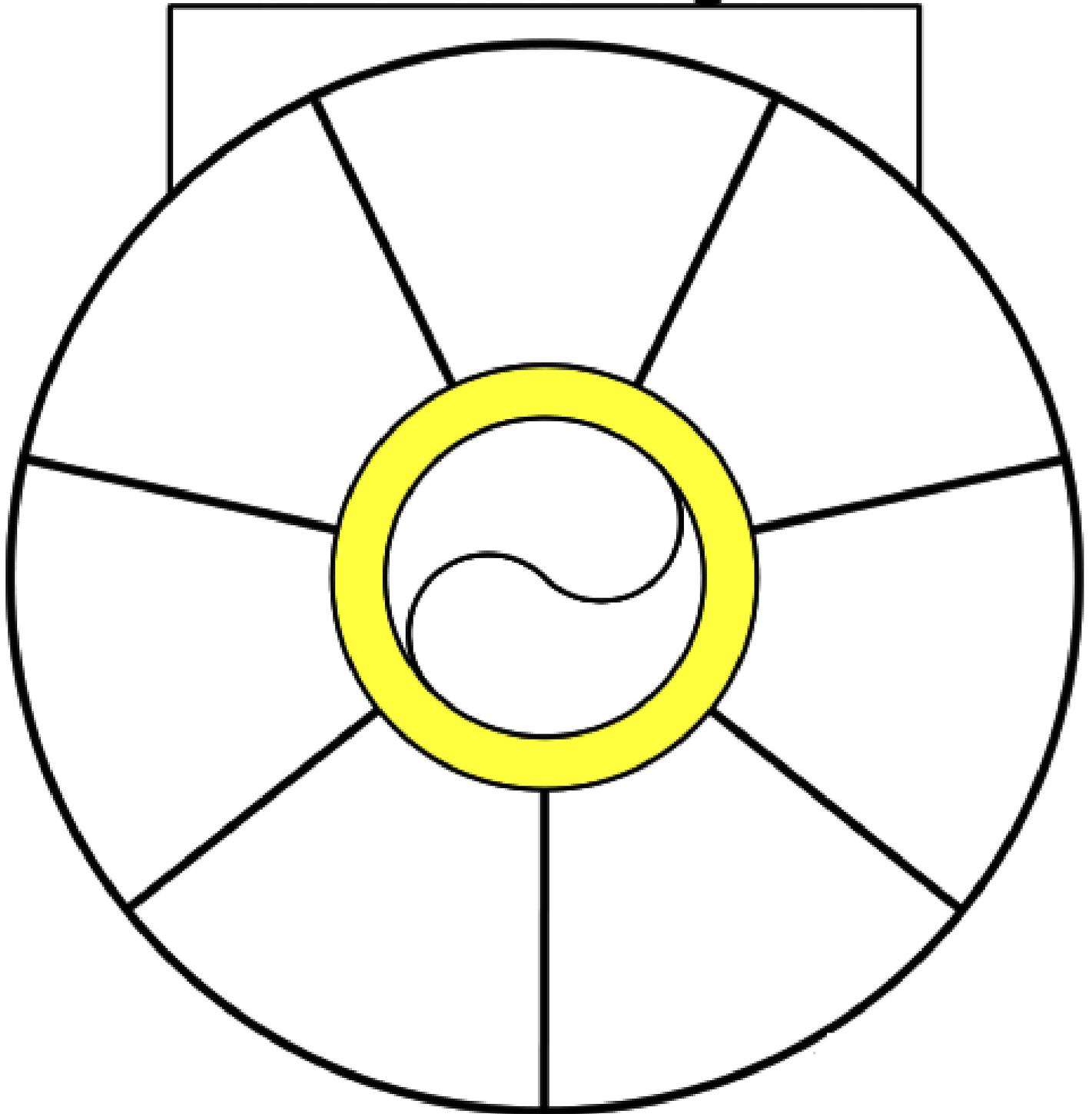
Macrophages: Activate CD 8 T cells

CD4⁺TFoxp3⁻ Cells: Destroyers (effectors)

The roundhouse template is on the following page.

Name: _____

Roundhouse Diagram



Goals: _____

Name: _____

Marking Parameter	Roundhouse Diagram Marking Scale									
	1	2	3	4	5	6	7	8	9	10
	_____ missing, partially proficient, proficient, good, exemplary									
Goals are clearly and neatly stated below the diagram	10 Marks									
	/10									
The title clearly cover the concepts stated in the diagram	Use of the “and” and “of”									
	/10									
The diagram includes the necessary key concepts	7 images and text chunks on the diagram									
	/10									
There are seven clearly defined concepts in the diagram	7 cells involved in T1D are clearly presented									
	/10									
The concepts are clearly and accurately stated	7 clearly and accurately written concepts on the diagram									
	/10									
There is an image in each section of the diagram which clearly and accurately represents the concept	Image correlates to the function of the cell type									
	/10									
The space is well used and the diagram is not too crowded	Text can be read, image can be understood.									
	/10									
The overall design is aesthetically pleasing in terms of balance, clarity, technique	Use of colour, neatness, proportionality of text and image									
	/10									
Creativity is evidenced	Artistic talent, humour, logic, organization									
	/10									
Overall impression of student work	Evidence of effort, neatness, relative performance									
	/10									
TOTAL MARKS	/100									

Lesson 2: Persuasive Writing Activity

Instructions: Read the following passages: Summary, Legal and Ethical, and the Case Study. In assigned groups, discuss and answer questions at the end of the case study.

TYPE I DIABETES RESEARCH AND THE NOD MOUSE

SUMMARY

Throughout history, diabetes has been a leading cause of death. Even with the availability of insulin therapy, it is estimated that approximately one-half million North Americans die as a result of its complications. It is a disease that touches millions of people in one way or another. People with type 1 diabetes (T1D) must inject insulin several times a day in order to metabolize glucose properly and live a normal life.

T1D also known as insulin-dependent or juvenile diabetes can occur at any age. It is most commonly diagnosed from infancy to the late 30s. A person with this type of diabetes has a pancreas that produces little or no insulin. Scientists believe the cause of this is due to the body's own immune system attacking and destroying the insulin-producing cells in the pancreas. In T1D, the body mistakes the beta cells (insulin producing) of the pancreas as "foreign." CD4 and CD8 T cells collaborate to attack and destroy the beta cells. Additionally, B cells make antibodies against the pancreatic beta cells but are not believed to be destructive. It is thought that CD4⁺ Foxp3⁺ regulatory T cells are integral in regulating this immune response and are thus studied extensively by scientists.

The non-obese diabetic (NOD) strain of mouse is a very useful model of type 1 diabetes. The NOD mouse was originally developed in Japan over 20 years ago when scientist were in-breeding a cataract-prone strain. The NOD mouse develops diabetes at 3 – 4 months of age with features very similar to those of human diabetics. These similarities are found in tissue, immunological, and metabolic functions of the two species. An advantage of studying a mouse that spontaneously develops type 1 diabetes is that it provides scientists the ability to study the early stages of the disease before symptoms occur. This allows researchers to focus on the underlying causes of the disease which could provide important answers to finding the cure for T1D.

LEGAL AND ETHICAL

Legal

The use of animals in research and teaching is a privilege governed by public concerns, federal and provincial laws and regulations, Canadian Council on Animal Care (CCAC) guidelines and policies, and McGill university policies, procedures, and guidelines. Individuals using or caring for animals at McGill or its affiliated institutions have a responsibility to the scientific community and society as a whole for proper stewardship of animals under their care.

McGill University and affiliated hospitals follow the guidelines established by the Canadian Council on Animal Care. All research, testing, and teaching programs involving the use of animals must be reviewed prior to the start of any experimental work to ensure that the animals are humanely cared for and that the “3R” tenet is respected: **replacing** the use of animals by alternative methods if possible, **reducing** the use of animals used and **refining** the techniques so pain and discomfort are minimized.

Ethical

Animals have been used in biomedical research since the early Greeks. Later, in Roman times physicians used vivisection techniques to do genuine experiments involving animals; testing specific hypotheses and exploring various explanations for scientific phenomenon. In the mid 19th century with the increasing popularity of pets, antivivisection sentiments became popular. These sentiments were responded to by Claude Bernard in his work, *Introduction to the Study of Experimental Medicine*. Bernard’s moral argument supported the use of animals in research and stated that the sacrifice of animals in research was essential to the advancement of medicine to relieve human suffering and extend human life.

Opponents to any kind of animal research which includes animal rights extremist and anti-vivisectionist believe that animal experimentation is cruel and not needed, regardless of its purpose or potential benefit. There seems to be no middle ground for these groups; the immediate and total abolition of all animal research is their goal.

Case Study: A Student is Upset

Kelly, an 11th grade honors students, was just back from lunch. She was sitting at her desk in the Study Hall waiting for the bell to ring for her 5th period biology class. Because she had a few more minutes, she decided to check her planner for the week. She noticed that a field trip to the local university microbiology and immunology labs was scheduled for her class this coming Friday. Kelly was very upset by this. She took the Biology elective course because it was suppose to be the study of living things, she thought, and the lab they were going to visit was engaged in basic medical research which entailed the killing of mice. She felt that this causes needless pain and suffering.

After the bell rang she went to class. She was the first student to arrive and she decided to tell her teacher, Mr. Judson, that she did not want to go on the mandatory field trip because she felt that medical research treated animals badly. She even had a note written by her mother asking for permission to be excused from the field trip. Mr. Judson reminded Kelly that the course syllabus stated that all students were required to go on the field trip.

Questions for discussion within your group

1. If you were Kelly, how would you respond to Mr. Judson?
2. Give three arguments Mr. Judson could use to convince Kelly that she should go on the field trip.
3. What are your personal feelings about using the use of NOD mice in Type I Diabetes research?

Individual Task: Write a five paragraph persuasive essay to convince the reader that your point of view on whether or not to use the NOD mouse in Type 1 Diabetes research is valid. Review the rubric prior on the following page prior to beginning your essay.

Persuasive Essay Rubric: Use of the NOD Mouse in Diabetes Research Self-Evaluation				
Criteria	4	3	2	1
The Claim	I make a claim and explain why it is controversial.	I make a claim and don't explain why it is controversial.	My claim is buried, and/or unclear.	I don't say what my argument or claim is.
Reasons in support of the claim	I give clear and accurate reasons in support of my claim.	I give reasons in support of my claim but I may overlook important reasons.	I give 1 or 2 weak reasons that don't support my claim and/or irrelevant or confusing reasons.	I do not give convincing reasons in support of my claim.
Reasons against the claim	I discuss the reasons against my claim and explain why it is valid anyway.	I discuss the reasons against my claim but leave some reasons out and/or don't explain why the claim still stands.	I say that there are reasons against the claim but I don't discuss them.	I do not acknowledge or discuss the reasons against the claim.
Organization	My writing has a compelling opening, an informative middle and a satisfying conclusion.	My writing has a beginning, middle, and end. It marches along but doesn't dance.	My writing is organized but sometimes gets off topic.	My writing is aimless and disorganized.
Voice and Tone	It sounds like I care about my argument. I show how I think and feel about it.	My tone is ok but my paper could have been written by anyone. I need to tell more about how I think and feel.	My writing is bland or pretentious. There is either no hint of a real person in it or it sounds like I'm a fake.	My writing is too formal or too informal. It sounds like I don't like the topic of the essay.
Word Choice	The words I use are striking but natural, varied and vivid.	I make routine word choices.	The words I use are often dull or uninspired or sound like I am trying too hard to impress.	I use the same words over and over and over. Some words may be confusing to a reader.
Sentence Fluency	My sentences are clear, complete, and of varying lengths.	I have well-constructed sentences.	My sentences are sometimes awkward, and/or contain run-ons and fragments.	Many run-ons, fragments and awkward phrasings make my essay hard to read.
Conventions	I use correct grammar, spelling, and punctuation.	I generally use correct conventions. I have a couple of errors I should fix.	I have enough errors in my essay to distract a reader.	Numerous errors make my paper hard to read.

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Lesson 3: Mouse Dissection Lab

Procedure:

Part I: Initial incisions, location and dissection of inguinal lymph nodes

1. Obtain a mouse, dissecting tray, dissecting kit and gloves from your teacher.
2. Fix the mouse on a flat surface (dissecting tray) with belly facing up using dissection pins. See Figure 1 below.
3. Using your forceps, lift the skin near the groin area. Using your scissors, cut only the skin beginning from the groin area along the midline of the body from groin to chin. BE CAREFUL TO CUT ONLY THE SKIN AND NOT THE MUSCLE WALL AND ORGANS BENEATH. See Figure 1 below.
4. Next, make an incision from the start of the first incision to down near the legs of the mouse. Do the same at the chin of the animal making a cut from the end of the first incision to down near the arms of the mouse.
5. Using forceps, carefully retract the skin back on both sides and use dissecting pins to anchor the skin. See Figure 2 below. Locate the inguinal lymph node (A). Using forceps remove the left inguinal lymph node and place it to the side in your dissecting tray.

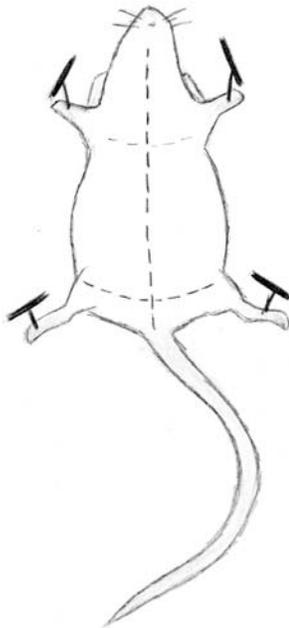


Figure 1

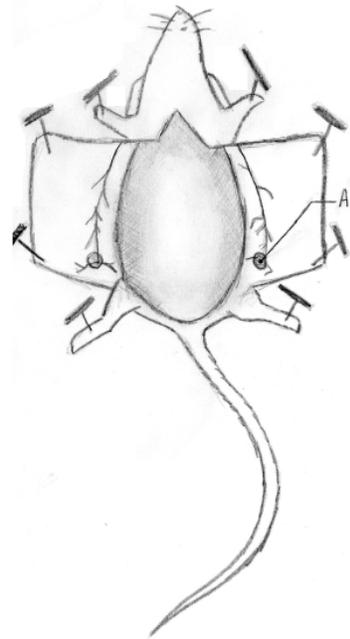


Figure 2

Part II: Opening of peritoneal wall with isolation and removal of spleen, pancreas, and thymus.

1. Using forceps, lift the peritoneal muscle wall and with scissors make the same incisions as you originally made through the subcutaneous tissue. The peritoneal muscle wall is slightly transparent so you will easily avoid damaging the underlying viscera.
2. Reflect the muscle back with forceps and use dissecting pins to hold muscle wall open. See Figure 3 below.
3. Using forceps, slightly reflect the intestinal viscera to your left to expose the spleen, Figure 3 (B).
4. Using scissors, cut and remove the spleen from its point of attachment and place it to the side in your dissecting tray.
5. Using forceps, reflect the intestinal viscera as far as you can to your left without detaching it. See Figure 4, (C) below. You will see the stomach, liver, and pancreas (white, grainy appearance). Using your forceps remove the pancreas from its anchors and place it to the side in your dissecting tray.
6. Using scissors, open the thoracic cavity up to the chin by cutting along the original incision lines you made in Part I, see Figure 1. You will see the heart and thymus, see Figure 4, (D). Using your forceps remove the thymus and place it to the side in your dissecting tray.
7. Make sketches of the lymphatic structures you have removed in your laboratory notebook. Begin cleanup.

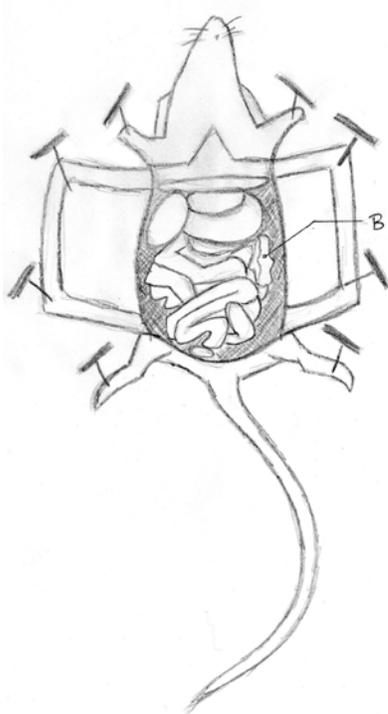


Figure 3

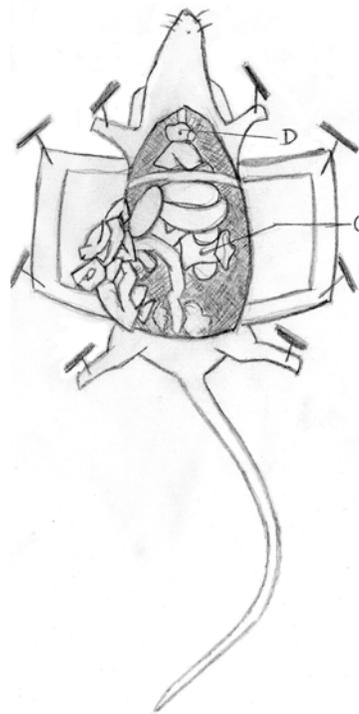


Figure 4

Lesson 4: Flow Cytometry Video

Instructions: Prior to viewing the video, please define the following vocabulary terms in the space provided. A starting point for your researching and defining these terms is:

http://en.wikipedia.org/wiki/Flow_cytometry

Flow	
Cyto	
Metry	
FACS	
Hydrodynamic Flow	
Fluidic System	
Lasers	
Optics	
Detectors	
Electronics and Peripheral Computer System	
Interrogation Point	

Lesson 5: T1D WebQuest

Instructions: After you have been placed you in a specific stakeholder group all the instructions for this activity are found at:

<http://questgarden.com/q/T1D>

IV. Data Collection

Lesson 3: Mouse Dissection Lab

As you isolate and remove the lymphatic structures (inguinal lymph node, spleen, pancreas, and thymus), make sketches of them in your lab notebook.

V. Discussion and Analysis

Lesson 3: Mouse Dissection Lab

You are to submit a complete lab report on for the mouse dissection.