

Beta Cells and Box Plots

TEACHER NOTES



Objectives

- Students will learn about the mechanism (destroyed beta cells) behind Type 1 Diabetes (T1D)
- Students will learn about the differences between Type 1 and Type 2 Diabetes
- Students will learn about how researchers use statistics to make decisions about data (Statistics that include Mean, Median, IQR, Box & Whisker Plots)
- Students will learn about the STEM career - Senior Lab Coordinator.

Vocabulary

- | | |
|----------------------------|---------------------------------------------------|
| • Type 1 Diabetes | • Type 2 Diabetes |
| • Mean | • Beta Cells |
| • Median | • Autoimmunity |
| • Interquartile Range, IQR | • Hyperglycemia |
| • Box & Whisker Plot | • Pancreas |
| • Statistics | • Insulin |
| • Glucose | • Hormone |
| • Lab Coordinator | • Immunofluorescent stains - DAPI, GFP, Texas Red |

About the Lesson

- The lesson follows two individuals working to fight Type 1 Diabetes in different ways – Katie Zucker and Camille Parker
- This lesson introduces the concepts of mean, median, and the box & whisker plot in the context of Type 1 Diabetes Research
- This lesson identifies the key differences between Type 1 and Type 2 Diabetes.
- Teaching time: one to two 45-minute class period(s)
- As a result, students will:
 - Understand how statistics can be used in scientific decision making as it relates to Type 1 Diabetes
 - Use simulations to understand the process of cell counting and immunofluorescent contrast staining



Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>.

Lesson Files:

Student Activity

- Beta Cells and Box Plots_student.pdf

TI-Nspire document

- Beta Cells and Box Plots.tns

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TI-Nspire™ Navigator™

- Send out the *Beta Cells & Box Plots.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies:  TI-Nspire™ CX Handhelds,  TI-Nspire™ Apps for iPad®,  TI-Nspire™ Software

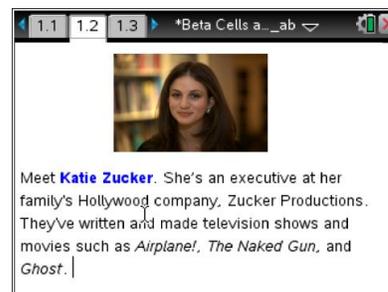
Background

STEM CAREER - This activity opens with an introduction to Katie Zucker, a Hollywood executive and a T1D patient. Katie is an advocate for medical research funding which can help labs like Sanford Research find a cure for T1D. Camille Parker, a senior lab coordinator for Sanford Research, is on the front lines of the fight. Her work in Dr. Alexei Savinov's lab has resulted in exciting results. Camille takes students through a common process of cell counting using immunofluorescent staining of cells in pancreatic tissue samples. Students will count cells identified as “replicating” and divide by the number of all other insulin-producing cells in the tissue sample to reveal a replication rate for that sample. With the use of different chemical treatments, Dr. Savinov's lab has shown that increasing the replication rate will increase the rate of insulin production, possibly reducing the amount of insulin injections required for T1 Diabetics. It's an exciting career pathway at Sanford Research for students to explore.

OVERVIEW – Students will count cells that are stained with immunofluorescent stains to reveal that some cells are replicating and therefore creating more insulin, naturally. The students are presented with data that shows that some chemical treatments yield higher replication rates. They must then analyze that data with statistics, specifically the mean and median. From there they will see that using box & whisker plots to display data allows them to quickly compare the center and spread of different treatments and choose the desirable treatment, in the context of this research.

Move to pages 1.2–1.4.

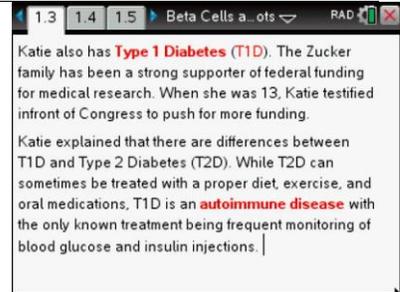
1. Students are introduced to Katie Zucker. Katie is an executive with her family's Hollywood company, Zucker Productions and she is also a Type 1 Diabetic. Katie has been pushing for more funding for medical research for a cure for T1D.



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- Students are introduced to the differences between Type 1 and Type 2 Diabetes as T1D is an autoimmune disease whereas T2D is not. Students will learn that there are many types of autoimmune diseases where certain cells are targeted.



1.3 1.4 1.5 Beta Cells a...ots RAD

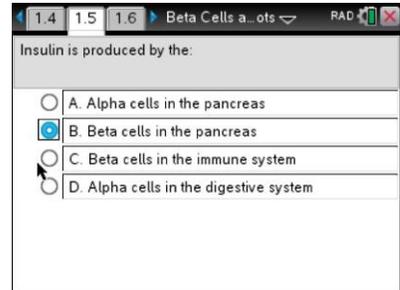
Katie also has **Type 1 Diabetes (T1D)**. The Zucker family has been a strong supporter of federal funding for medical research. When she was 13, Katie testified in front of Congress to push for more funding.

Katie explained that there are differences between T1D and Type 2 Diabetes (T2D). While T2D can sometimes be treated with a proper diet, exercise, and oral medications, T1D is an **autoimmune disease** with the only known treatment being frequent monitoring of blood glucose and insulin injections.

Move to page 1.5. Answer questions here or in the .tns file.

Q1. Insulin is produced by the:

Answer: B. Beta cells in the pancreas



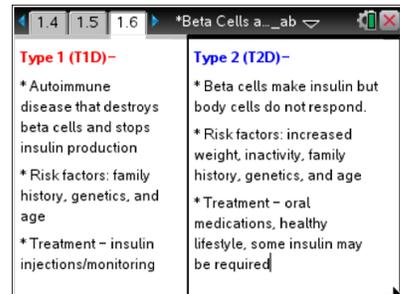
1.4 1.5 1.6 Beta Cells a...ots RAD

Insulin is produced by the:

- A. Alpha cells in the pancreas
- B. Beta cells in the pancreas
- C. Beta cells in the immune system
- D. Alpha cells in the digestive system

Move to pages 1.6-1.7.

- Page 1.6 compares the differences of Type 1 and Type 2 Diabetes. Students should see that T2D can sometimes be treated with a healthy diet, moderate exercise and oral medication. T1D can't be treated with these methods and requires insulin-replacement therapy instead.
- Page 1.7 introduces students to Sanford Research which is on the front lines of fighting Type 1 Diabetes.



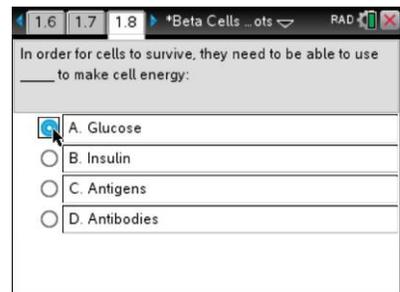
1.4 1.5 1.6 *Beta Cells a...ab RAD

Type 1 (T1D)-	Type 2 (T2D)-
* Autoimmune disease that destroys beta cells and stops insulin production	* Beta cells make insulin but body cells do not respond.
* Risk factors: family history, genetics, and age	* Risk factors: increased weight, inactivity, family history, genetics, and age
* Treatment - insulin injections/monitoring	* Treatment - oral medications, healthy lifestyle, some insulin may be required

Move to page 1.8. Answer questions here or in the .tns file.

Q2. Which organ produces insulin?

Answer: A. Glucose



1.6 1.7 1.8 *Beta Cells ...ots RAD

In order for cells to survive, they need to be able to use ____ to make cell energy:

- A. Glucose
- B. Insulin
- C. Antigens
- D. Antibodies

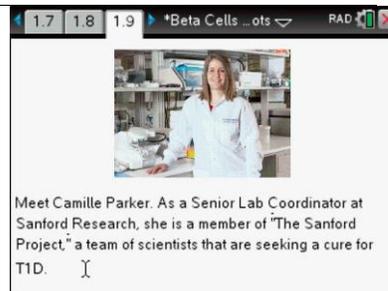
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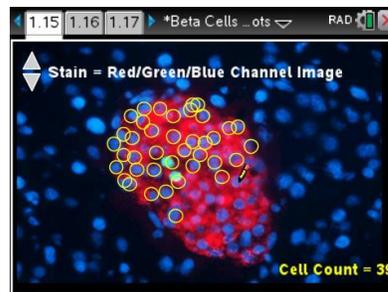
Move to pages 1.9—1.12.

- Page 1.9 introduces students to Camille Parker, a senior lab coordinator at Sanford Research under Dr. Alexei Savinov's lab. Camille discusses what she does for a living and her role in fighting T1D.



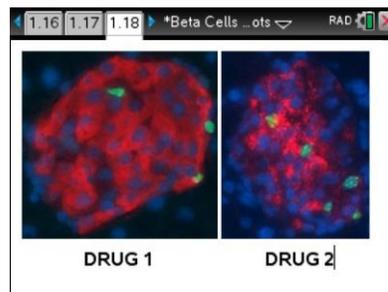
Move to pages 1.13—1.16.

- Pages 1.13 to 1.16 take students into the lab as they learn about the different immunofluorescent stains and their specific targets in the cells. Through simulations and images of actual tissue samples supplied by Sanford, students will do cell counting just like the researchers at Sanford in an effort to determine the replication rate of beta cells! Students should realize the importance of setting up a well-controlled experiment since the results could potentially help hundreds of thousands of people.



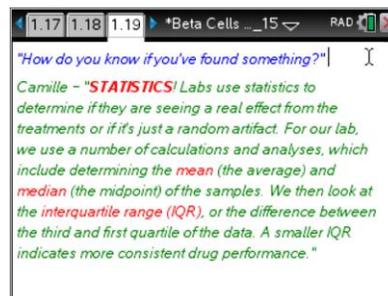
Move to pages 1.17—1.18.

- Pages 1.17 and 1.18 explain to students that the researchers at Sanford experiment with different treatments to increase the replication rate of beta cells. The faster the beta cells replicate, the more insulin will be produced and less injections a patient will potentially require.



Move to pages 1.19—1.20.

- Pages 1.19 and 1.20 explain to students that Camille requires statistics to know how to tell if the data collected is reliable. Students will review the concept of **MEAN** before moving into the **MEDIAN** and **IQR**.



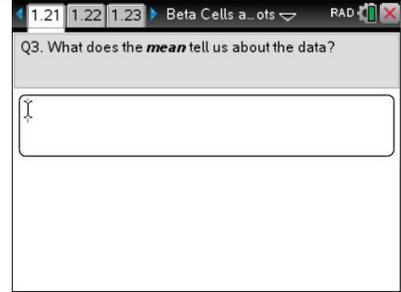
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Move to page 1.21 and 1.22. Answer questions here or in the .tns file.

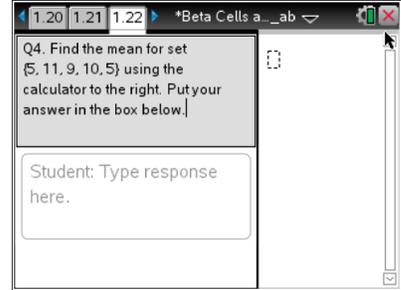
Q3. What does the **mean** tell us about the data?

Answer: Answers will vary. Students should describe the mean as the sum of all the data points divided by the number of data points. The mean is not the middle of the data but instead it reveals the average value of the data points in the set.



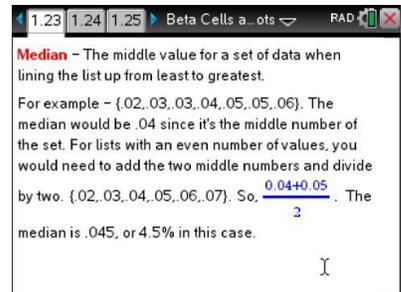
Q4. Find the mean for set {5, 11, 9, 10, 5}, using the calculator to the right. Put your answer in the box below?

Answer: 8



Move to page 1.23.

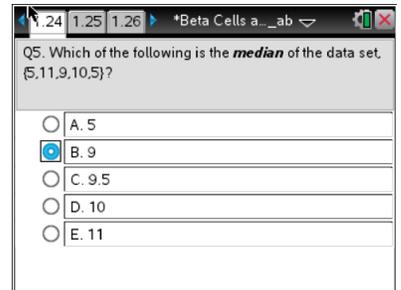
9. Page 1.23 introduces the concept of **Median**.



Move to page 1.24. Answer questions here or in the .tns file.

Q5. Which of the following is the median of the data set {5, 11, 9, 10, 5}?

Answer: B. 9

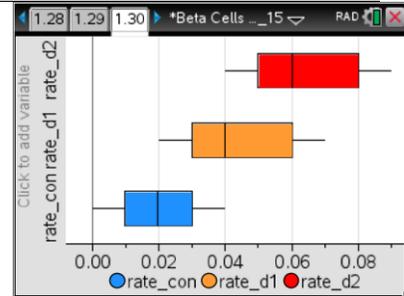


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Move to pages 1.25—1.30.

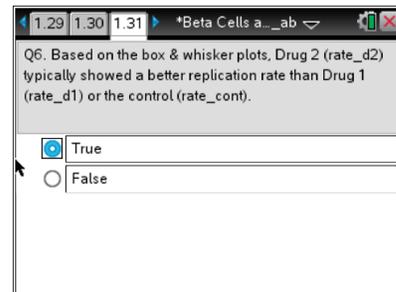
10. Pages 1.25 through 1.30 take a look at the need for a large number of samples to rule out the potential for a random event. Have students consider the overlap of the three treatments. If only a small number of patients had been used, it's possible that the data would have shown only a small or even no difference in the three treatments. Because scientists conduct many trials (in Dr. Savinov's lab, it's 500 of each treatment), they can look at the data sets with a high level of confidence. Students are also introduced to the idea of the box & whisker plot as a way to visualize the spread of the data away from the median.



Move to pages 1.31 and 1.32. Answer questions here or in the .tns file.

Q6. Based on the box & whisker plots, Drug 2 (rate_d2) typically showed a better replication rate than Drug 1 (rate_d1) or the control (rate_cont)?

Answer: True



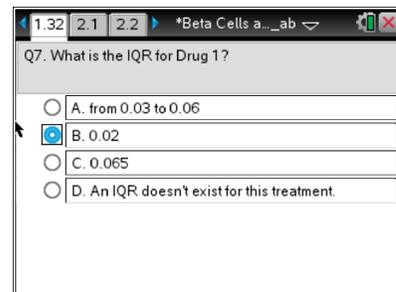
Q6. Based on the box & whisker plots, Drug 2 (rate_d2) typically showed a better replication rate than Drug 1 (rate_d1) or the control (rate_cont).

True

False

Q7. What is the *IQR* for Drug 1?

Answer: B. 0.02



Q7. What is the IQR for Drug 1?

A. from 0.03 to 0.06

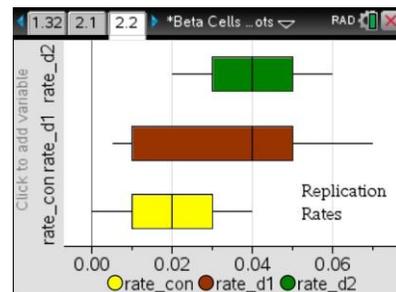
B. 0.02

C. 0.065

D. An IQR doesn't exist for this treatment.

Move to page 2.1—2.3.

11. Pages 2.1 to 2.3 present a scenario to students where they need to evaluate three box & whisker plots and determine which of the three treatments shows the most promising results. Students should realize that although rate_d1 and rate_d2 have identical medians, the mean of d2 is higher, and d1 has a much wider spread with many rates less than 0.01! Rate_d2 has a narrower spread indicating that it will be more consistent when



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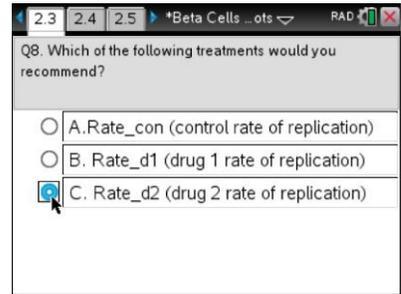
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administered to patients.

Move to pages 2.3--2.5. Answer questions here or in the .tns file.

Q8. Which of the following treatments would you recommend?

Answer: C. Rate_d2 (Drug 2 rate of replication)



Q8. Which of the following treatments would you recommend?

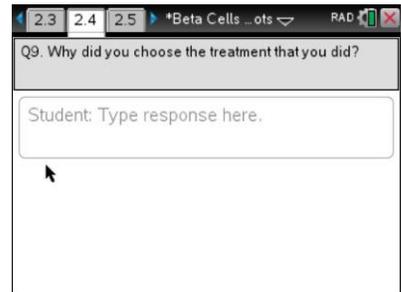
A. Rate_con (control rate of replication)

B. Rate_d1 (drug 1 rate of replication)

C. Rate_d2 (drug 2 rate of replication)

Q9. Why did you choose the treatment that you did?

Answer: Answers will vary. Students should indicate that Drug 2 would be the best choice. Although Drug 1 has the same median as Drug 2, it also has a much wider spread and lower minimum and Q1, indicating less effectiveness and consistency when compared to Drug 2.

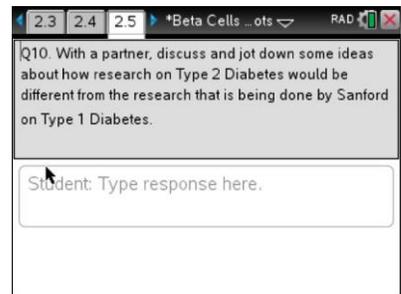


Q9. Why did you choose the treatment that you did?

Student: Type response here.

Q10. With a partner, discuss and jot down some ideas about how research on Type 2 Diabetes would be different from the research that is being done by Sanford on Type 1 Diabetes?

Answer: Answers will vary. Students may indicate that research on Type 2 Diabetes will be based on the effects of diet and exercise while research on Type 1 Diabetes is more focused on determining how to replace the insulin that is lost with damaged beta cells.

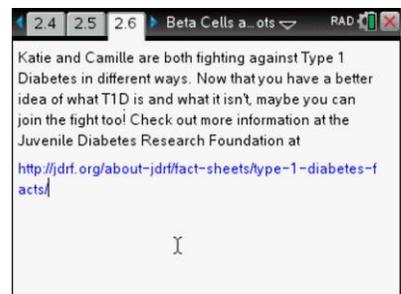


Q10. With a partner, discuss and jot down some ideas about how research on Type 2 Diabetes would be different from the research that is being done by Sanford on Type 1 Diabetes.

Student: Type response here.

Move to page 2.6.

12. This page concludes the activity with a reminder that both Katie Zucker and Camille Parker are fighting Type 1 Diabetes in two very different ways. A link to the Juvenile Diabetes Research Foundation is available for students to explore even more information about T1D.



Katie and Camille are both fighting against Type 1 Diabetes in different ways. Now that you have a better idea of what T1D is and what it isn't, maybe you can join the fight too! Check out more information at the Juvenile Diabetes Research Foundation at <http://jdrf.org/about-jdrf/fact-sheets/type-1-diabetes-facts/>

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TI-Nspire Navigator Opportunities

Make a student the Live Presenter to demonstrate his or her asteroid simulation graphs.

Assessment

- Students will answer questions throughout the lesson to ensure they understand the concepts of Type 1 and 2 Diabetes, the use of statistics in scientific decision making, and careers related to fighting disease.

The Juvenile Diabetes Research Foundation (JDRF) has published a fact sheet about Type 1 Diabetes which is very helpful in understanding the disease.

Check it out at <http://jdrf.org/about-jdrf/fact-sheets/type-1-diabetes-facts/> .