Biosensors Activity Data Lesson

Background: Using nanoscale biosensors requires very accurate procedures and detailed analysis of results. This ensures that the equipment is working properly, and that samples are being analyzed correctly.

Part 1:

A researcher at Michigan State University was testing known concentrations of bacteria in triplicate (to ensure accurate results) and received the following data( note: CFU means colony forming units, mohms means micro-ohms):

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | Resistance (mohms) | | | |
| CFU/ml | | Trial 1 | | Trial 2 | Trial 3 |
| 0 (Blank) | | 10.5 | | 9.8 | 8.7 |
| 1 | | 10.2 | | 10.5 | 9.9 |
| 1\*10^1 | | 13.4 | | 14.1 | 14.4 |
| 1\*10^2 | | 16.8 | | 16.1 | 17.2 |
| 1\*10^3 | | 21.3 | | 20.4 | 10.6 |
| 1\*10^4 | | 24.6 | | 25.8 | 24.3 |
| 1\*10^5 | | 25.4 | | 26.7 | 24.4 |
| 1\*10^6 | | 26.4 | | 24.3 | 25.1 |
| 1\*10^7 | | 25.7 | | 25.3 | 26.1 |
| 1\*10^8 | | 25.3 | | 25.9 | 24.9 |
|  |  | |

1. Analyze the data. Are there any outliers (data that clearly seems inconsistent or out of the expected range? If there are, what would you suggest the researcher should do? Throw it out? Average it? Keep it in the data set? Why do you think this?
2. The scientist reran the 1000 cfu/ml sample and received a result of 19.9 mohms.

Using a graphing calculator or website like http://easycalculation.com/statistics/standard-deviation.php, find the averages (mean) and standard deviations of the data.

Record and plot the averages on the blank graph provided.

\*\*Note that the the x-axis is logarithmic.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Resistance (mohms) | | |  |  |
| CFU/ml | Trial 1 | Trial 2 | Trial 3 | Average | Standard Deviation |
| 0 | 10.5 | 9.8 | 8.7 |
| 1 | 10.2 | 10.5 | 9.9 |
| 1\*10^2 | 13.4 | 14.1 | 14.4 |
| 1\*10^3 | 16.8 | 16.1 | 17.2 |
| 1\*10^4 | 21.3 | 20.4 | 19.9 |
| 1\*10^5 | 24.6 | 25.8 | 24.3 |
| 1\*10^6 | 25.4 | 26.7 | 24.4 |
| 1\*10^7 | 26.4 | 24.3 | 25.1 |
| 1\*10^8 | 25.7 | 25.3 | 26.1 |
| 1\*10^9 | 25.3 | 25.9 | 24.9 |

(PUT BLANK GRAPH HERE)

1. What does it mean to have a significant difference?
2. What is the lowest concentration that is significantly different from the blanks?
3. Which concentrations are not significantly different from each other? What does this mean if a resistance value is found to be 23.5 mohms?

Part 2:

1. A meat processing facility decided to test the accuracy of the nano-biosensor technology by sending some samples to the lab for review. The plant managers knew which meat samples had been handled and stored safely and included some samples that had not been properly handles and refrigerated. They did not reveal which sample was which to the lab staff.

The researchers than tested the ground beef samples and received the following results.

|  |  |  |  |
| --- | --- | --- | --- |
|  | mohm |  |  |
| Sample | 1 | 2 | 3 |
| 1 | 9.8 | 10.6 | 9.7 |
| 2 | 25.4 | 23.2 | 23.9 |
| 3 | 13.4 | 14.3 | 11.5 |
| 4 | 10.5 | 10.2 | 9.9 |
| 5 | 16.8 | 15.4 | 16.1 |
| 6 | 9.6 | 9.8 | 10.1 |
| 7 | 8.6 | 9.1 | 9.3 |
| 8 | 11.5 | 12.2 | 11.9 |
| 9 | 9.7 | 9.8 | 10.1 |
| 10 | 10.2 | 9.6 | 8.9 |
|  |  |  |  |

Find the averages and standard deviations of each. Which samples could have bacterial contamination? How did you make this decision?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mohm |  |  |  |  |
| Sample | 1 | 2 | 3 | Average | Stnd Dev |
| 1 | 9.8 | 10.6 | 9.7 |
| 2 | 9.6 | 11.5 | 10.4 |
| 3 | 25.4 | 23.2 | 23.9 |
| 4 | 10.5 | 10.2 | 9.9 |
| 5 | 16.8 | 15.4 | 16.1 |
| 6 | 9.6 | 9.8 | 10.1 |
| 7 | 8.6 | 9.1 | 9.3 |
| 8 | 11.5 | 12.2 | 11.9 |
| 9 | 9.7 | 9.8 | 10.1 |
| 10 | 10.2 | 9.6 | 8.9 |

1. From the graph you made previously, an equation can be fitted to the data points. This can be completed using Excel.

The equation found was CFU/ml = 1.562\*ln(resistance)+10.07.

Use the equation to find the approximate bacterial concentration of each sample.]

1. What would you suggest should be done with the meat source of the samples that you believe are contaminated?