Annex : Calculation of Mean and Standard Deviation

- A cholesterol control is run 20 times over 25 days yielding the following results in mg/dL:

  192, 188, 190, 190, 189, 191, 188, 193, 188, 190, 191, 194, 194, 188, 192, 190, 189, 189, 191, 192.

- Using the cholesterol control results, follow the steps described below **to establish QC ranges**. An example is shown on the next page.

1. Make a table with 3 columns, labeled A, B, C.
2. Insert the data points on the left (column A).
3. Add Data in column A.
4. Calculate the mean: Add the measurements (sum) and divide by the number of measurements (n).

$$\text{Mean} = \frac{\sum x_1 + x_2 + x_3 + \ldots x_n}{N} \qquad \frac{3809}{20} = \mathbf{190.5\ mg/dL}$$

5. Calculate the variance and standard deviation: (see formulas below)

   a. Subtract each data point from the mean and write in column B.
   b. Square each value in column B and write in column C.
   c. Add column C. Result is 71 mg/dL.
   d. Now calculate the variance: Divide the sum in column C by n-1 which is 19. Result is **4 mg/dL**.
   e. The variance has little value in the laboratory because the units are squared.
   f. Now calculate the SD by taking the square root of the variance.
   g. The result is **2 mg/dL.**

A	B	C
Data points. X_1-Xn	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
192 mg/dL	1.5	2.25 mg^2/dL^2
188 mg/dL	-2.5	6.25 mg^2/dL^2
190 mg/dL	-0.5	0.25 mg^2/dL^2
190 mg/dL	-0.5	0.25 mg^2/dL^2
189 mg/dL	-1.5	2.25 mg^2/dL^2
191 mg/dL	0.5	0.25 mg^2/dL^2
188 mg/dL	-2.5	6.25 mg^2/dL^2
193 mg/dL	2.5	6.25 mg^2/dL^2
188 mg/dL	-2.5	6.25 mg^2/dL^2
190 mg/dL	-0.5	0.25 mg^2/dL^2
191 mg/dL	0.5	0.25 mg^2/dL^2
194 mg/dL	3.5	12.25 mg^2/dL^2
194 mg/dL	3.5	12.25 mg^2/dL^2
188 mg/dL	-2.5	6.25 mg^2/dL^2
192 mg/dL	1.5	2.25 mg^2/dL^2
190 mg/dL	-0.5	0.25 mg^2/dL^2
189 mg/dL	-1.5	2.25 mg^2/dL^2
189 mg/dL	-1.5	2.25 mg^2/dL^2
191 mg/dL	0.5	0.25 mg^2/dL^2
192 mg/dL	1.5	2.25 mg^2/dL^2

$\sum x = 3809$ $\sum = \mathbf{-1}$ $\sum (x_i - \bar{x})^2$ Sum of Col C is 71 mg^2/dL^2

$SD = \sqrt{S^2} = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n-1}}$ mg/dL $SD = \sqrt{S^2} = \sqrt{71}/19 = 2 mg/dL$

The square root returns the result to the original units.

The **sum** of the squared differences of each value from the mean (column C) **is 71.**

Notes:
a) In the calculations for variance, n-1 is used rather than n. This has been shown to reduce bias and provide a more true measure of variation. Therefore, for 20 data points, n-1 = 19.
b) S^2 is the variance, SD is the square root.

Calculate the Ranges

The mean of these data is 190.5, and the SD is 2.

To calculate the acceptable ranges for use in quality control decisions:

1. Range for 1 SD: Subtract the SD from the mean (190.5 – 2 = 188.5)

   Add the SD to the mean (190.5 + 2 = 192.5)

   ➔ Range for 1 SD is 188.5 - 192.5.

2. Range for 2 SD: Multiply the SD by 2 (2 x 2 = 4)
   Add and subtract 4 from the mean (190.5)

   ➔ Range for 2 SD is 186.5 - 194.5.

3. Range for 3 SD: Multiply the SD by 3 (2 x 3 = 6)
   Add and subtract 6 from the mean (190.5)

   ➔ Range for 3 SD is 184.5 – 196.5.

Next make Levey-Jennings charts by plotting the mean and SD.
See content sheets 7-4 and 7-5 for details.