Homework 3

6.24.Provide a point and interval estimate(95% confidence interval) for the mean zone diameter across laboratories for each type of control strain, if each laboratory uses different meida to perfrom the susceptibility tests.

Solution. The point estimate of the mean zone diameter is the mean of zone diameters across all the nine laboratories, because each laboratory has the same number of tests performed. Since each data in the cell of table 6.10 is the mean of 150 tests, so according to the Central Limit Theory, although we don't know the distribution of each test result, the mean has normal distribution. From Equation 6.6 of the textbook, we know how to get the confidence invertal. (We use this formular because the standard deviation of each mean is unkown). For the E.coli, I have these result:

$$\bar{x} = (27.5 + 24.6 + 25.3 + 28.7 + 23.0 + 26.8 + 24.7 + 24.3 + 24.9)/9 = 25.53$$
$$s^2 = [(27.5 - 25.5)^2 + (24.6 - 25.5)^2 + \cdots + (24.9 - 25.5)^2]/(9 - 1) = 3.18$$
$$s = \sqrt(s^2) = 1.78$$
$$t_{9-1,0.975} = t_{8,.975} = 2.306$$
$$\alpha = 0.05$$
$$(\bar{x} - t_{n-1,1-\alpha/2}s/\sqrt(n), \bar{x} + t_{n-1,1-\alpha/2}s/\sqrt(n)) = (24.16, 26.90)$$

The other two are similar and you can get the following result:

	Point estimate	95% CI
E.coli	25.53	(24.16,26.90)
S.aureus	26.79	(24.88,28.70)
P.aeruginosa	19.93	(18.60,21.27)

6.25 Answer Problem 6.24 if each laborotary uses a common medium to perform the susceptibility tests.

Solution. The method is the same as the last one.

	Point estimate	95% CI
E.coli	25.06	(23.73,26.38)
S.aureus	25.44	(24.60,26.29)
P.aeruginosa	17.89	(17.09,18.69)

6.26 Provide a point and interval estimate(95% confidence interval) for the interlaboratory standard deviation of the mean zone diameters for each type of control strain, if each laboratory uses different meida to perfrom the susceptibility tests.

Solution. We know that the sample variance is an unbiased point estimation of squared standard deviation. (Equation 6.10) So the point estimation of standard deviation is just the square root of that quantity. And from Equation 6.15 we know how to get the confidence interval.

$$s^2 = 3.18(\ from\ Problem\ 6.24)$$
$$\alpha = 0.05$$
$$\chi_{9-1,0.975} = 17.53$$
$$\chi_{9-1,0.025} = 2.18$$
$$[(n-1)s^2/{\chi^2}_{n-1,1-\alpha/2}, (n-1)s^2/{\chi^2}_{n-1,\alpha/2}] = [1.45, 11.67]$$

So to get the confidence interval we need to take quare root of what we get from above. The 95% confidence interval for σ is [1.20,3.42]. Similarly you can get the other two:

	Point estimate	95% CI
E.coli	1.78	(1.20,3.42)
S.aureus	2.49	(1.68,4.77)
P.aeruginosa	1.74	(1.17,3.32)

6.27 Answer Problem 6.26 if each laboratory uses a common medium to perform the susceptibility tests.

Solution. The method here is quit similar to the last one.

	Point estimate	95% CI
E.coli	1.73	(1.17,3.31)
S.aureus	1.10	(0.75,2.12)
P.aeruginosa	1.04	(0.70,1.99)

6.28 Are there any advantages to using a common medium versus using different meida for performing the susceptibility tests with regard to standardization of results across laboratories?

Solution. Since we want to get precise result, the less variation across laboratories the better the method is.With all the three type of control stain, the "Common medium" has smaller sample variance than "Different Media". So the "Common medium" method is better.

7.1 If the mean and standard deviation of serum creatinine in the general population are 1.0 and 0.4 mg/dL, repectively, then, using a significance level of .05, test if the mean serum-creatinine level in this group is different from that of the general population.

Solution. This problem tells us the mean and standard deviation of the general population, which means that the μ_0 and σ are known. So we can use the Equation 7.13.

$$
\begin{aligned}
&z = (\bar{x} - \mu_0)/(\sigma/\sqrt{n}) = (1.2 - 1.0)/(.4/\sqrt{12}) = 1.732 \\
&\alpha = .05 \\
&z_{\alpha/2} = z_{.025} = -1.96 \\
&z_{1-\alpha/2} = z_{1-.025} = -z_{.025} = 1.96
\end{aligned}
$$

Here, our $H_0 : \mu = 1.0$ and $H_1 : \mu \neq 1.0$,where μ is the true mean of serum-creatinine level of each individual in the sample. According to the decision rule in Equation 7.13 and the fact that $-1.96 < z = 1.732 < 1.96$, we accept H_0 at the 5% level.

7.2 What is the p-value for the test?

Solution. Here the hypothesis is two sided, so according to Equation 7.13, the exact p-value is $2[1 - \Phi(1.732)] = 2 \cdot .0418 = .0836$.

7.19 If the probability of an A in the 20th position is .79 in ribosomal 5S RNA, then test the hypothesis that the new sequence is the same as ribosomal 5S RNA using the critical-value method.

Solution. This problem is about proportion, so we should use the Equation 7.42. Usually we choose $\alpha = .05$.

$$
\begin{aligned}
&\hat{p} = 60/100 = .6 \\
&p_0 = .79 \\
&n = 100 \\
&z_{\alpha/2} = z_{.025} = -1.96 \\
&z_{1-\alpha/2} = z_{.0975} = 1.96 \\
&z = (\hat{p} - p_0)/\sqrt{p_0 q_0/n} = (.6 - .79)/\sqrt{.79(1 - .79)/100} = -4.66
\end{aligned}
$$

According to Equation 7.42, since $z < z_{\alpha/2}$, H_0 is rejected.

7.20 Report a p-value corresponding to your results in Problem 7.19.

Solution. From Equation 7.43, we know the p-value is $2 \cdot \Phi(-4.66) = 0$.