7.2.3

(a) There is significant evidence; p=0.085<0.1=alpha.
(b) There is not significant evidence; p=0.065>0.05=alpha.

7.2.9

R code:

```
> normoxia=c(3.45,3.09,3.09,2.65,2.49,2.33,2.28,2.24,2.17,1.34)
> hypoxia=c(6.37,5.69,5.58,5.27,5.11,4.88,4.68,3.50)
> t.test(normoxia,hypoxia)

        Welch Two Sample t-test

data:  normoxia and hypoxia
t = -7.417, df = 12.212, p-value = 7.307e-06
alternative hypothesis: true difference in means is not equal to 0
```

Let mu1 be the mean blood flow after 5 minutes of bicycle exercise of all normoxia inhalers and mu2 be the blood flow from all hypoxia inhalers after 5 minutes of bicycle exercise. We reject H0: mu1=mu2 at the alpha=0.05 significance level because p=0.0000073 < 0.05=alpha.

7.2.10

R code:

```
> d14=c(29.6,21.5,28.0,34.6,44.9)
> d15=c(32.7,40.3,23.7,25.2,24.2)
> t.test(d14,d15)

        Welch Two Sample t-test

data:  d14 and d15
t = 0.4943, df = 7.716, p-value = 0.6348
```

(a) Let mu1 be the mean weight of all chick thymus glands after 14 days incubation in mg and mu2 be the mean weight after 15 days incubation. We accept H0: mu=mu2 at the alpha=0.1 significance level because p=0.63 > 0.1=alpha.
(b) The SE of the mean difference is sqrt(8.73^2/5+7.19^2/5)=5.1 mg. This is quite large relative to the actual difference 2.5 mg, so this could have easily happened by chance.

7.2.14

(a) P=0.03<0.05=alpha, we reject H0 because the p-value is less than the significance level. True.
(b) True.
(c) True.
(d) True.

(e) True. This is the definition of the p-value!
(f) False.

7.2.17

```
> control=   c(3.4,1.6,4.4,2.9,3.5,2.3,2.9,2.8,2.7,2.5,2.6,2.3,3.7,1.6,
+              2.7,1.6,2.3,3.0,2.0,2.3,1.8,3.2,2.3,2.0,2.4,2.6,2.5,2.4)
> fertilized=c(2.8,1.9,1.9,2.7,3.6,2.3,1.2,1.8,2.4,2.7,2.2,2.6,3.6,1.3,
+              1.2,3.0,0.9,1.4,1.5,1.2,2.4,2.6,1.7,1.8,1.4,1.7,1.8,1.5)
> t.test(control,fertilized)

        Welch Two Sample t-test

data:  control and fertilized
t = 2.9507, df = 53.503, p-value = 0.004696
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.1739334 0.9117809
```

Let mu1 be the mean height (cm) of all radish sprouts under control settings and mu2 be the mean height of all radish sprouts planted in aluminum planters with fertilizer sticks. Since p=0.004 < 0.05=alpha, we reject that there is no difference in mean height from these two populations: aluminum planters with fertilizer sticks significantly affect radish sprout growth. We are 95% confident that growth is typically increased between 0.8 and 0.9 cm under control conditions.

7.3.4

The FDA approving of the drug means it is affective, i.e. the alternative HA was chosen. The only type of error that could have occurred is Type I, rejecting H0 when it is true.

7.3.5

Type II.

7.3.6

The 95% CI for mu1-mu2 does not include zero. We reject H0: mu1=mu2 at the 5% level.

7.3.7

A 95% CI for mu1-mu2 does not include zero. A 90% CI will be even smaller and centered at -4.85 (midpoint between -7.4 and -2.3), also not containing zero, therefore we reject H0: mu1=mu2 at the 10% level.

7.4.1

No, association does not imply causation in an observational study. One answer might be that people with lower respiratory illnesses move to Arizona in higher numbers to get better. Another is that many older people retire there, and they might be more prone to lower respiratory illness.

7.9.1

(a) False. Either H0 is true or not (we don’t know which).
(b) True; if the p-value is less than the significance alpha, we reject.
(c) False. If we repeat the experiment there is a 5% chance of a Type I error.
(d) True.

7.9.1

```
> experimental=c(5.32,5.60,5.74,6.06,6.32,6.34,6.79,7.18)
> control=c(4.50,4.78,4.79,4.86,5.41,5.70,6.08,6.21)
> t.test(experimental,control)

        Welch Two Sample t-test

data:  experimental and control
t = 2.7571, df = 13.968, p-value = 0.01545
alternative hypothesis: true difference in means is not equal to 0

> t.test(experimental,control,alternative="greater")

        Welch Two Sample t-test

data:  experimental and control
t = 2.7571, df = 13.968, p-value = 0.007727
alternative hypothesis: true difference in means is greater than 0
```

Let mu1 be the population mean respiration of those about to be hypnotized and mu2 be the pop’n mean respiration of those not about to be hypnotized.

(a) The p-value (above) is p=0.015; we reject H0: mu1=mu2 at the 5% level and conclude HA: mu1 not equal mu2. There is a significant difference in the mean respiration (liters/minute/m^2) between people about to be hypnotized vs. those not about to be hypnotized.
(b) The p-value (above) is p=0.008; we reject H0: mu1=mu2 at the 5% level and conclude HA: mu1>mu2. The mean respiration (liters/minute/m^2) among people about to be hypnotized is significantly higher than those not about to be hypnotized.
(c) The one-sided test is appropriate for a one-sided alternative.

7.5.13

```
> m250=c(0.318,0.758,0.318,0.637,0.372,0.524,0.196,0.637,1.404,0.624,1.560,0.000,
+       0.909,0.207,1.061,0.295,0.685,0.590,0.594,0.000,0.363,0.442,1.303,1.567,
+       1.220,0.898,1.577,1.303,1.157,0.312,0.187,0.970,0.758,1.560,0.624,0.505,
```

```
+       0.849,1.592,0.909,2.411,1.019,0.362,1.705,0.829,0.329,1.019,0.884,0.909)
> m800=c(0.941,0.289,0.399,0.279,0.392,0.955,1.021,0.725,0.531,0.108,1.318,0.252,
+       0.738,0.612,1.179,0.907,0.637,0.442,0.503,0.181,0.291,0.637,0.941,0.579,
+       1.498,0.265,0.252,0.866,0.979,0.373,0.588,0.909,0.000,0.606,0.283,0.463,
+       0.490,0.337,1.248,0.163,0.813,2.010,0.277,0.000,1.213,0.293,0.544, 0.808)

> t.test(m250,m800,alternative="greater")

        Welch Two Sample t-test

data:  m250 and m800
t = 1.995, df = 89.843, p-value = 0.02454
alternative hypothesis: true difference in means is greater than 0
```

Let mu1 be the settler density (juvenile fish per unit of settlement habitat) of all patch reef settlements at 250 meters from the reef crest, and mu2 the settler density of all patch reef settlements at 800 meters from the reef crest. Since p=0.024 < 0.10=alpha, we reject H0: mu1=mu2 in favor of HA: mu1>mu2 at the 10% significance level. That is, there is statistically significant evidence that settler density decreases as distance from the reef crest increases.

7.7.1

sigma=0.3 cm. Jones has |mu1-mu2|=0.25 cm and power=0.80; Smith has |mu1-mu2|=0.5 cm and power=0.95. The sample sizes are computed:

```
>
power.t.test(delta=0.25,sd=0.3,sig.level=0.05,power=0.80,type="two.samp
le",alternative="two.sided")

     Two-sample t test power calculation

              n = 23.60472
          delta = 0.25
             sd = 0.3
      sig.level = 0.05
          power = 0.8
    alternative = two.sided

 NOTE: n is number in *each* group

>
power.t.test(delta=0.5,sd=0.3,sig.level=0.05,power=0.95,type="two.sampl
e",alternative="two.sided")

     Two-sample t test power calculation

              n = 10.42380
          delta = 0.5
             sd = 0.3
      sig.level = 0.05
          power = 0.95
    alternative = two.sided

 NOTE: n is number in *each* group
```

Jones needs 24 in each group; smith only needs 11.

7.7.3(a)

The R code for this gives 4 plants in each group; note that alternative is one-sided here:

```
>
power.t.test(delta=2,sd=0.8,sig.level=0.05,power=0.90,type="two.sample"
,alternative="one.sided")

     Two-sample t test power calculation

              n = 3.678026
          delta = 2
             sd = 0.8
      sig.level = 0.05
          power = 0.9
    alternative = one.sided

 NOTE: n is number in *each* group
```

7.10.3

```
> toluene=c(3420,2314,1911,2464,2781,2803)
> control=c(1820,1843,1397,1803,2539,1990)
> wilcox.test(toluene,control)

        Wilcoxon rank sum test

data:  toluene and control
W = 32, p-value = 0.02597
alternative hypothesis: true location shift is not equal to 0
```

(a) Since p=0.026<0.05=alpha, we reject H0: the population distributions of dopamine from toluene and control populations are the same at the 5% significance level and conclude that they are different.

```
> wilcox.test(toluene,control,alternative="greater")

        Wilcoxon rank sum test

data:  toluene and control
W = 32, p-value = 0.01299
alternative hypothesis: true location shift is greater than 0
```

(b) Since p=0.013<0.05=alpha, we reject H0: the population distributions of dopamine from toluene and control populations are the same at the 5% significance level and conclude that dopamine tends to be higher in toluene-exposed rats.

7.10.3

```
> joggers=c(39,40,32,60,19,52,41,32,13,37,28)
> program=c(70,47,54,27,31,42,37,41,9,18,33,23,49,41,59)
> wilcox.test(joggers,program)
```

```
        Wilcoxon rank sum test with continuity correction

data:  joggers and program
W = 71.5, p-value = 0.5854
alternative hypothesis: true location shift is not equal to 0

Warning message:
In wilcox.test.default(joggers, program) :
  cannot compute exact p-value with ties
```

Ignore the "ties" warning. Since p=0.58>0.1=alpha, there is <u>not</u> statistically significant evidence that distributions of HBE differ between joggers and fitness program entrants (at the 10% significance level).