Lipid Profiles

***Important: Read over the section on correlation coefficients in the* Guidelines for Statistics and Graphs in General Education Biology.**

Objectives:
1. Learn about the different lipids that make up a lipid profile.
2. Practice using scatter plots and the correlation coefficient to assess relationships between two variables.

Introduction:
A lipid profile is a measurement of various lipids that are found in the blood. This kind of blood test is often used to assess risk of heart disease.

There are two common concerns people have about lipids in their diet: One is their high caloric value, which may lead to undesired weight gain. The other is their association with high total cholesterol levels, which are a risk factor for cardiovascular disease. Limiting the intake of fat and oil in the diet, especially saturated fats, may help keep cholesterol levels low and thus lower one's risk of heart disease.

One reason the USDA recommends that 10% or fewer of one's calories come from saturated fats is because the amount of saturated fat in one's diet correlates strongly with cholesterol levels. Saturated fats are generally solid at room temperature. Fat from animals (e.g. butter and lard) is almost always saturated, but some oils from plants are saturated, too (e.g. palm oil or coconut oil.)

A lipid profile contains information about several different kinds of lipid that normally circulate in the blood. Values are numerical, but in order to simplify explanation, ranges of numerical values are often placed into categories such as 'low risk,' or 'high risk.' For example, a total cholesterol level over 240 mg/dl is said to be 'high risk', but that doesn't mean a reading of 238 is fine. With total cholesterol and LDL cholesterol the higher the number, the higher the risk. Conversely, the lower the LDL cholesterol, the lower the risk. However, a low number is not a guarantee against heart disease. The population with low cholesterol is at lower risk of heart disease, but heart disease is not absent in this population.

All of these lipid levels need to be evaluated in the context of other risk factors. If you have several other risk factors, a cholesterol level of 200 mg/dl might be considered a problem, while if you have no other risk factors, it might not be. Some of the other risk factors for cardiovascular disease are: smoking, high blood pressure, diabetes, age of over 45 years for males, age of over 55 years for females, and a family history of early heart disease.

Lipids generally included in a blood lipid profile are described below. Units for these are mg/dl, or milligrams per deciliter. A deciliter is $1/10^{th}$ of a liter.

Triglycerides: This is the most common type of lipid formed in animals. Fat tissue is primarily for the storage of this form of lipid. Triglyceride levels vary quite a bit over short time periods. A meal high in sugar, fat, or alcohol can raise the triglyceride level drastically, so the most repeatable measures of this lipid are taken after 12 hours of fasting. Even though sugar and alcohol are not lipids, your body will convert any form of excess calories into triglycerides for long-term storage. A value below 150 mg/dl indicates no increased risk, 150 -200 indicates a slight risk, and over 200 mg/dl is a high risk.

Cholesterol : Cholesterol is a necessary molecule in human metabolism. It is a component of cell membranes, and is a building block of bile, estrogen and testosterone. The cholesterol necessary for normal metabolism is manufactured by the liver. Generally, a level less than 200 mg/dl is considered desirable. Between 200 mg/dl and 240 mg/dl is considered borderline high, and over 240 mg/dl is considered high.

Cholesterol is present in the blood in three forms. The three defined below are all combinations of protein, cholesterol, and triglyceride. Cholesterol is a lipid and is insoluble in water. It is transported through the blood encased in a soluble protein.

LDL Cholesterol, or Low density lipoprotein: This is sometimes referred to as the "bad cholesterol." This form contains the highest amount of cholesterol. A value between 130 – 159 mg/dl is borderline high, and over 160 mg/dl is considered 'high."

HDL Cholesterol, or High density lipoprotein: This is sometimes called "good cholesterol." The higher the number, the better. A value below 40 mg/dl is considered a risk factor. A value above 60 mg/dl is considered protective against heart disease. HDL cholesterol is cholesterol that is packaged for delivery to the liver, where the cholesterol is removed from the body.

VLDL cholesterol -- Very-low density lipoprotein; this form contains the highest amount of triglyceride. Like LDL, this is considered "bad cholesterol." A value less than 32 mg/dl is desirable. VLDL is usually not measured directly, but is estimated from the triglyceride count by dividing the triglyceride count by 5. This mathematical way to estimate VLDL is not valid when the triglyceride is above 400 mg/dl.

LDL/HDL cholesterol ratio: Based on what you have read above, what would be the value of someone in at low risk? At high risk?

Total cholesterol/HDL ratio: Based on what you have read above, what would be the value of someone at low risk? At high risk?

Methods:
Examine the table at the end of the lab handout, which contains blood lipid profiles for a number of RU students.

A. When we discussed Nutrition you may have noticed that a number of dietary factors increase LDL and decrease HDL, or vice versa. One might suspect that these two lipids are negatively correlated, that is, when one is high the other must be low. Let's test this possibility with the RU student data we have.

1. Make a scatter plot of the HDL and LDL data from the table, as described in the Statistics and Graphing handout. Make sure you follow the guidelines for making graphs.

2. The instructor used the template described in the handout to calculate the correlation coefficient for these data. The results were:

$$r = -0.20 \qquad n = 37$$

3. Examine your scatter plot and the calculated coefficient. Note that the critical regions, as described in the handout, for various *n* values are shown in the table on the next page. Do they support or fail to support the hypothesis that these two lipids are negatively correlated? Explain how you can tell.

Critical Regions for the correlation coefficient for various sample sizes

Sample size (n)	Critical Region
10	-0.632 to +0.632
11	-0.602 to +0.602
12	-0.576 to +0.576
13	-0.553 to +0.533
14	-0.532 to +0.532
15	-0.514 to +0.514
20	-0.444 to +0.444
30	-0.361 to +0.361
40	-0.312 to +0.312
60	-0.254 to +0.254
80	-0.220 to +0.220
100	-0.197 to +0.197
120	-0.180 to +0.180
140	-0.166 to +0.166
160	-0.155 to +0.155
180	-0.146 to +0.146
200	-0.138 to +0.138
250	-0.124 to +0.124
300	-0.113 to +0.113
350	-0.105 to +0.105
400	-0.098 to +0.098
450	-0.092 to +0.092

B. Are people with high levels of triglycerides in the blood also high in cholesterol? One might think so if these people ate a lot of animal fat and diet was the only factor that controlled lipid levels. Let's test this also.

1. Before you start make a hypothesis based on what you suspect. Are triglycerides and cholesterol levels positively correlated (they are high or low together), or negatively correlated (when one is high the other is low), or not correlated at all?

2. Make a scatter plot of the Triglyceride and Cholesterol data from the table, as described in the Statistics and Graphing handout. Make sure you follow the guidelines for making graphs.

3. The instructor used the template described in the handout to calculate the correlation coefficient for this data. The results were:

   $r = 0.39 \qquad n = 37$

4. Examine your scatter plot and the calculated coefficient. Do they support or fail to support your hypothesis? Explain how you can tell.

C. Examine the lipid data in the table. Pick the two or three students you believe are at greatest risk of developing heart disease and explain why you say this.

Bibliography:

Cholesterol American Heart Association. 2005. Accessed March 10, 2005. <http://www.americanheart.org/presenter.jhtml?identifier=1516>

Cholesterol Center. Mayo Clinic. 2005. Accessed March 10, 2005. <http://www.mayoclinic.com/invoke.cfm?id=DS00178>

National Heart, Lung, and Blood Institute. Department of Health and Human Services. National Institutes of Health. Accessed 10 Mar. 2005 <http://www.nhlbi.nih.gov.health/public/heart/#chol>

SEX	AGE	TRIGLYCERIDE mg/dl	CHOLESTEROL mg/dl	HDL mg/dl	VLDL mg/dl	LDL mg/dl	LDL/HDL ratio	Total CHOLESTEROL/ HDL
F	19	56	154	34	11	109	3.2	4.5
F	27	36	178	81	7	90	1.1	2.2
F	18	40	179	48	8	123	2.6	3.7
F	19	97	200	47	19	134	2.9	4.3
F	19	83	180	53	17	110	2.1	3.4
F	20	152	199	54	30	115	2.1	3.7
F	22	39	203	70	8	125	1.8	2.9
F	20	72	227	64	14	149	2.3	3.5
F	20	41	162	52	8	102	2	3.1
F	19	139	214	63	28	123	2	3.4
F	20	38	152	45	8	99	2.2	3.4
F	19	71	158	54	14	90	1.7	2.9
F	40	57	169	41	11	117	2.9	4.1
F	19	127	200	43	25	132	3.1	4.7
F	19	120	167	55	24	88	1.6	3.0
F	19	77	208	46	15	147	3.2	4.5
F	20	45	171	48	9	114	2.4	3.6
F	18	62	158	43	12	103	2.4	3.7
F	19	81	133	45	16	72	1.6	3.0
F	19	37	147	46	7	94	2	3.2
F	18	64	215	58	13	144	2.5	3.7
F	20	43	129	40	9	80	2	3.2
F	19	93	195	65	19	111	1.7	3.0
F	19	144	252	41	29	182	4.4	6.1
F	19	34	174	51	7	116	2.3	3.4
F	19	82	192	47	16	129	2.7	4.1
F	20	25	159	69	15	111	1.2	2.3
F	20	47	141	94	9	38	0.4	1.5
F	19	44	205	48	14	143	3	4.2
M	20	26	113	37	5	71	1.9	3.1
M	21	106	186	38	21	127	3.3	4.9
M	20	73	152	33	15	104	3.2	4.6
M	20	183	189	27	37	125	4.6	7.0
M	22	26	152	52	5	95	1.8	2.9
M	34	111	140	38	22	80	2.1	3.7
M	24	191	173	23	38	112	4.9	7.5
M	25	33	199	56	7	136	2.4	3.6