Physiology of Exercise (PED 30W)

Laboratory Report Format:

For some labs you may only be required to hand in specific sections (i.e. *Methods* or *Results*). For others, a complete lab report consisting of *Introduction*, *Methods*, *Results* and *Discussion* sections will be required. These reports comprise an important part of your learning experience (and of your grade), so an understanding of what is required is essential. If you have not done so before, go to the library and read several original research articles about topics in Exercise Science or related areas. Look for articles in journals such as Medicine and Science in Sports and Exercise, Research Quarterly for Exercise and Sport and Journal of Applied Physiology. This will help you to acquire a feel for the style and format of scientific papers.

Reports should be typed (double spaced, with 1 inch margins) and follow the format described in the following sections.

Important reminders:

1. Follow as closely as possible the style and format used in professional journals.
2. The vast majority of your references should be of original research articles (not reviews or textbooks).
3. Copying from published sources constitutes plagiarism and will expose the student to disciplinary action by the College. *Introduction* and *Discussion* sections are places for you to demonstrate your understanding of the topic by summarizing pertinent information in your own words (with appropriate references to the sources of this knowledge). They are not opportunities to copy phrases, sentences or paragraphs from other people's work (even if you do properly reference the source).

Examples of Sections of a research report:

Introduction – This section is used to give some background and explain the purpose of the research. Using references to previous research, put the experiment into perspective relative to current theory. A good introduction section will leave the reader with a clear sense of why the experiment was done. Before writing an introduction, a bit of reading and reflecting about the topic needs to be done.

The following are excerpts from introduction sections:

"Target RPEs obtained in this way have been shown to be accurate for regulating exercise intensity (6, 8, 9)."

"It is possible that patients with cardiac disease may exhibit different perceptual responses from healthy individuals. This in turn might alter the accuracy of exercise prescriptions developed using the Three Point Method. Therefore, the current investigation was undertaken to examine the accuracy of the Three Point Method for developing perceptually based exercise prescriptions for patients with cardiac disease (Dunbar, Glickman-Weiss, Edwards, Conley & Quiroz, 1996)."

"Most investigators agree that performance not-withstanding, pre-exercise ingestion of $Na^{+}HCO_3^{-}$ increases blood pH and/or retards the decrease in blood pH during exercise (17). However, of the investigations that have specifically quantified blood pH changes in response to dietary or exercise interventions, none have measured blood pH changes during recovery. Understanding the recovery kinetics of blood pH is essential for multiple sprint or intermittent activities such as soccer, rugby, or hockey." (Robergs, R.A., Hutchinson, K., Hendee, S., Madden, S., Siegler, J.C.)

Notice that factual statements are followed by reference numbers which indicate where the information was obtained. Also note the style; the author is giving some background and pointing out the knowledge gaps in the area as a lead up as to why the study was done.

The following example again shows how the problem is developed and current investigation rationalized.

"Bioelectrical impedance analysis (BIA) has become a common method of estimating body composition. Several investigations have found less than optimal accuracy for the BIA method (Hutcheson, Latin, Berg, & Pentice, 1988; Jackson, Pollock, Graves, & Mahar, 1988; Van Der Kooy et al., 1992; Vasquez & Janosky, 1991; Watanabe, Nakadomo, Miyake, Tanaka, & Maeda, 1992). Possible sources of error have been identified. These include: variations in hydration levels (Kahled et al., 1988; Katch, 1985; Malina, 1987), arm positioning (Schell & Gross, 1987), skin temperature (Caton, Mole, Adams, & Heustis, 1988), phase of the menstrual cycle (Deurenberg, Weststrate, Paymans, & Van Der Kooy, 1988), inter-observer variability (Schell & Gross, 1987) and electrode positioning (Schell & Gross, 1987). Given the apparent technical simplicity of test administration, the finding of inter-observer variability initially seems puzzling. We hypothesized that much of the inter-observer variability is due to differences in electrode positioning. Although the manufacturer supplies written and pictorial instructions for electrode placement, the authors have observed inter- and intratester variability in electrode placement. Using a group of 10 women as subjects, Schell and Gross (1987) reported that central movement of electrodes by 1 cm can significantly change the measured resistance. The effect of misplacements of electrodes does not appear to have been systematically investigated. Therefore, the current investigation was undertaken to systematically examine the effects various combinations of small (1 cm) changes in electrode placement on the accuracy of body composition estimation by BIA." (Dunbar, Melahrinides, Michielli & Kalinski, 1994).

Notice the referencing of previous work in the area and the identification of areas where more information is needed. The reader should be left with a clear sense of why this study was needed.

Methods – This section describes the procedures followed and equipment used. A good methods section has enough detail to allow another investigator to duplicate your experiment. Although it should give enough detail for replication, it should not be overly descriptive of non-essential items. Here are excerpts from a Methods section of a paper published in Research Quarterly.

"After being weighed, subjects were instructed to lay supine on a padded examination table with the arms and legs abducted slightly. Arm and leg positioning was held constant for all trials. 22 body composition measurements were then taken as follows...electrode positions specified by the manufacturer are: wrist - superior linear border in a line bisecting the ulnar head, hand - metacarpal-phalangeal joint of 3rd digit, ankle - superior linear border in a line bisecting the medial malleolus, foot - metatarsal-phalangeal joint of 3rd digit. Following this trial 20 additional trials were performed wherein 1 or more electrodes was moved 1 cm from the proper location. In 16 of these trials 1 electrode was moved proximally, distally, medially or laterally while the other electrodes were left in the proper positions. The standard pre-trial was always performed first and the standard post-trial last. The order of the other 20 trials was randomized." (Dunbar et al, 1994)

"Plyometric sessions lasted approximately 10-15 minutes and were conducted three times per week during practice. The plyometric sessions were scheduled on alternate days from the strength training sessions. Explosive jumping (box jumps), quickness (timed jumping, re-jumping), and power endurance (skipping for height and distance) were stressed during the plyometric workouts. Typical training sessions used either the width of the soccer field or the 18-yard box. The exercises progressively increased in quantity and intensity as the fitness level improved throughout the season (3 to 5 sets). In addition, the jumping heights were increased. All plyometric sessions were conducted after skill-specific soccer sessions were completed. Individual data on both strength and plyometric performance were recorded throughout the experimental period. The investigator conducted all training sessions. A summary of the training program for the EG is given in Table 4." (Siegler et al, 2002)

One must consider the purpose of the study when writing a Methods section. Since the first presented methods section looked at the effects of misplacement of electrodes it was critical to establish where the electrodes were placed. In other studies such anatomical detail is often not needed.

Here are excerpts from another study which involved the measurement of standard respiratory/metabolic parameters such as VO_2.

"During the estimation and production trials expired air was analyzed for fractional concentrations of oxygen (Applied Electrochemistry S-3A analyzer) and carbon dioxide (Beckman LB-2 analyzer). Inspired volume was measured with a Parkinson-Cowan Dry Gas Meter. Gas analyzers and the flow meter were inter-faced with an Apple Microcomputer and software (Rayfield Equipment) providing real time calculations of respiratory gas exchange data, VO_2 and V_E. Heart rate during exercise was determined by a one lead electrocardiograph with hardwire transmission (Hewlett Packard model 1500B)." (Dunbar et al, 1992)

Note how the equipment is specified, but extensive details of data collection are not given. This is because a standard technique of open circuit spirometry was used. Other scientists in the field would be familiar with the techniques, so extensive detail was not needed.

Results - The Results section should simply present your factual findings. Interpretation and opinions related to these findings should be included in the Discussion, not in the Results. Notice the dry style of the following excerpt from a Results sections:

Heart rate
Intra-modal: The differences between means for heart rate are shown in Table III. Heart rate for E1 and P1 differed by 10.4 beat * min -1 at 50% VO2MAX and 26.8 beat * min -1 at 70% VO_2max." (Dunbar et al, 1992)

Figures and Tables
Tables and/or graphs of the data should also be included in the Results. Use accepted (e.g., APA) format for all tables, graphs and figures. Some examples are given on the following pages.

Table 1. Mean±SD data for the mono-exponential slopes and half time recovery constants for each blood acid-base parameter.

	Slope		$t_{0.5}$	
Trial	**pH**	**Lactate**	**pH**	**Lactate**
ACD	0.057±0.01	0.040±0.02	12.67±3.50*	23.37±9.47
PLAC	0.080±0.02	0.030±0.03	9.83±2.73*	35.81±24.58
ALK	0.050±0.01	0.020±0.01	15.51±3.45*	36.63±19.66

*=significantly different from lactate ($p<0.01$)

Table 2: Change in mass and body composition with training.

VARIABLE:	GROUP	PRE (Means±S.D.)	POST (Means±S.D.)	CHANGE (PRE – POST) (Means±S.D.)
Body Weight (kg)	CG	58.00±7.23	58.14±7.65	-0.04±1.82
	EG	61.46±9.43	61.21±9.26	-0.25±1.82
FFM (kg)	CG	48.96±4.63	49.56±4.88	0.59±1.84
	EG	49.33±6.37	50.48±6.92 $^{\alpha}$	1.14±1.22
FM (kg)	CG	9.17±4.11	8.54±4.07	-0.63±1.61
	EG	12.13±4.66	10.73±4.26 $^{\alpha}$	-1.40±1.47

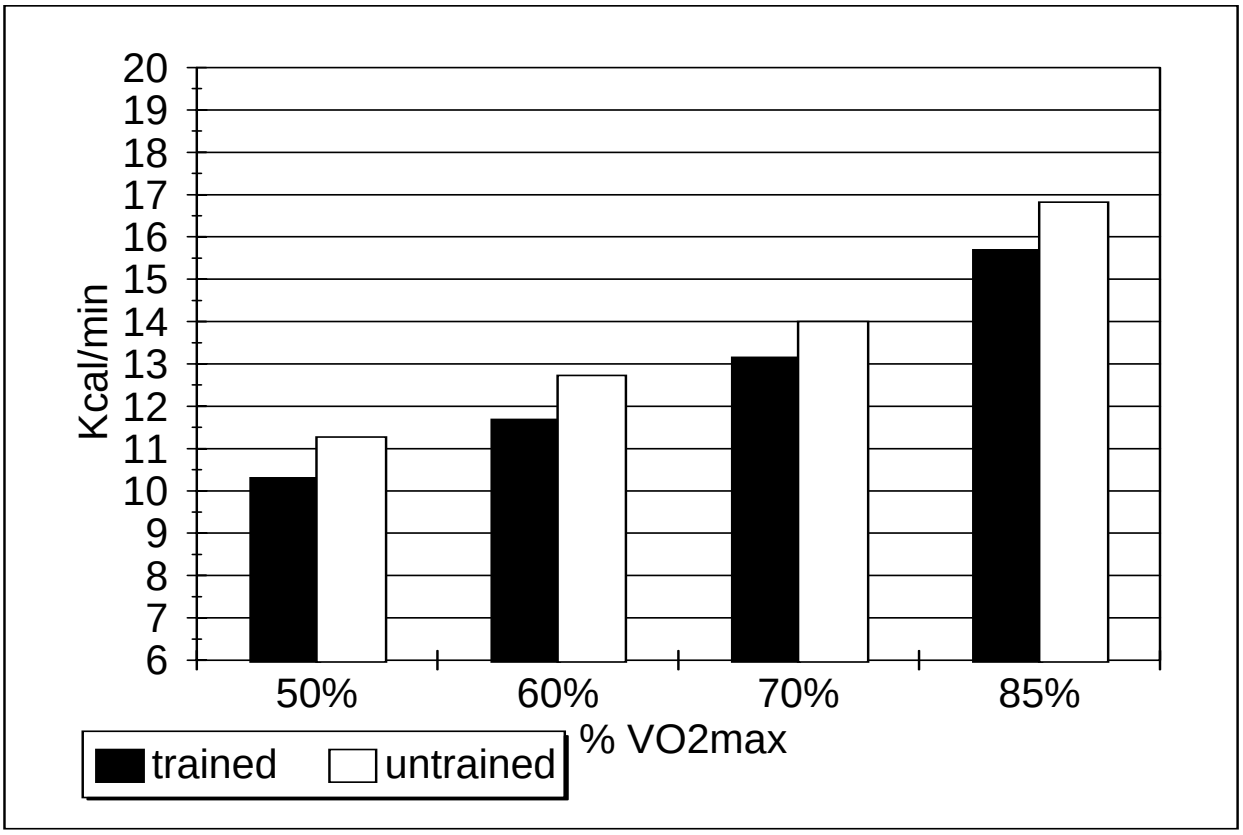

Figure 1. Caloric expenditure of trained and untrained subjects at various percentages of maximal oxygen consumption.

Bar graphs are sometimes useful for comparing two or more groups or conditions. Notice once again that the title clearly explains what is being graphed. Units of measure (kcal/min) are identified and the data is organized in a meaningful way.

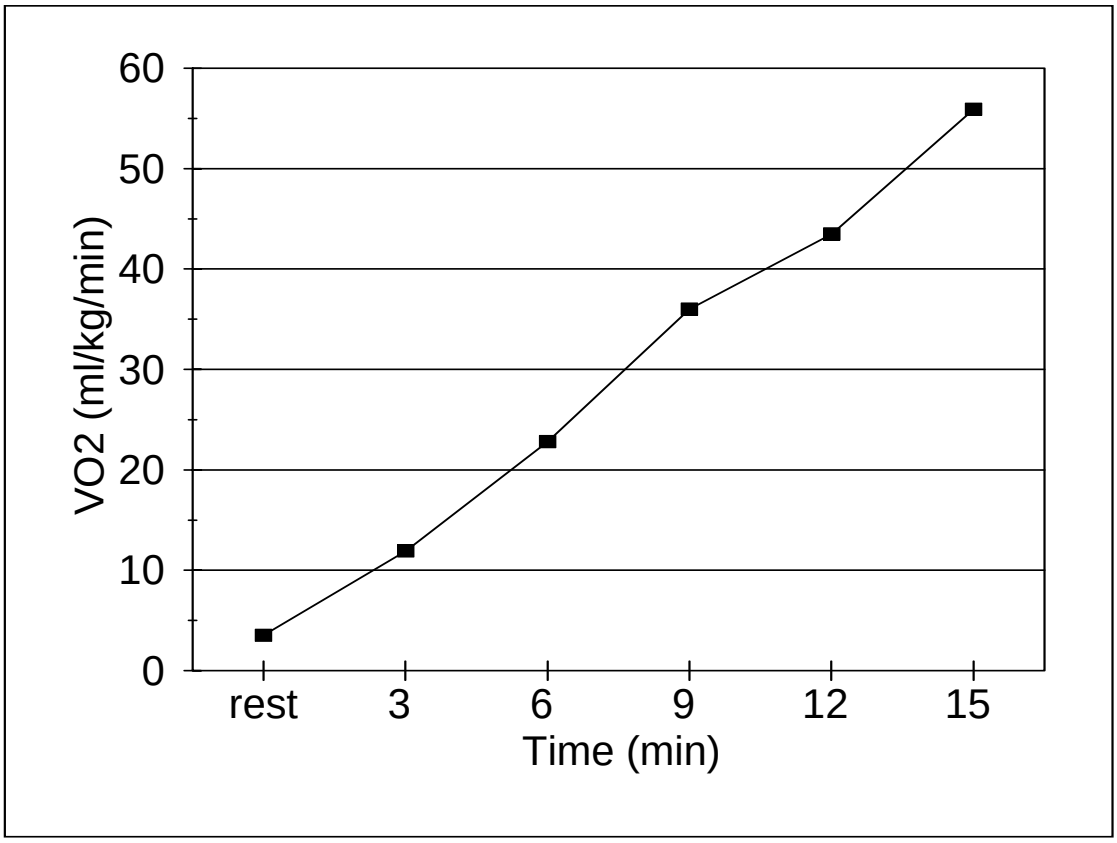

Fig. 2. Oxygen consumption during a Bruce Protocol Graded Exercise Test.

Line graphs are useful when a variable is compared over time. Again notice how the title clearly explains what is being graphed. Other types of figures such as pie charts or XY plots may be appropriate depending on the nature of your data. In general, keep in mind that a figure is meant to display your data in a way which makes it easier to understand.

Discussion – Use this section to discuss and interpret your results. What did you find? Do your results agree with previous research findings and/or theoretical models? If not, give possible explanations. A good discussion section puts the results of your experiment into perspective, integrating your findings with previous work in a way that advances understanding of the topic under investigation. Discussions are often the hardest part to write, particularly when the experiment does not turn out quite the way that you had planned. Here are some examples.

"Our data are in agreement with Schell and Gross (1987) who found that 1 cm misplacement of electrodes significantly affected BIA results..." (Dunbar et al, 1994)

If your findings are in line with what is expected, the usual approach is to say this with references supporting this conclusion (as shown above). If your findings are not in line with what would be expected you must try to explain why as in the following example.

"The present findings differ somewhat with previous studies that found a greater perceptual production accuracy at higher exercise intensities when VO_2 and heart rate were employed as the criterion variables (5,16,30). Using VO_2 as the physiological criterion, the present investigation found that the intra-modal regulation of exercise intensity according to a target RPE which had been estimated during treadmill testing was less accurate at comparatively higher than lower metabolic rates. In contrast, Smutok et al (30) and Bayles et al (5) found perceptual regulation of exercise intensity to have the greatest accuracy at higher intensities during intra-modal treadmill exercise...

Several methodological factors may explain the above inconsistencies. Smutok et al (30) appear to have been interested in the accuracy of regulating locomotor velocity using a predetermined RPE. The present subjects were not instructed to produce a prescribed treadmill speed, but rather to produce the target level of perceived exertion. From a neurosensory standpoint, it is likely that the perception of speed is fundamentally different from the perception of exertion for the overall body. Asking subjects to attend to differing sensations i.e., velocity vs. overall exertion may explain some of the contrasting results. The differences in perceived exertion between walking and running during the intra-modal treadmill trials also seem to have effected both Smutok's (30) findings and those of the present investigation. Subjects in both studies often chose to walk during the estimation trial and run during the production trials. The relatively slow speeds and steep grades of our estimation protocol virtually ensured that the present subjects would choose to walk during much of the treadmill estimation trial. The use of 0% grade during treadmill production trials made it likely that many subjects would choose to run during production trials. It is well established that heart rate and RPE will differ between walking and running at most velocities within the locomotor range(27). The nature of the testing protocol may also be important. The estimation protocol of Smutok et al (30) used a level treadmill for all exercise intensities, a procedure that differed markedly from the present investigation. The estimation protocols used by Eston et al (16) and Bayles et al (5) also were quite different from that used presently. It seems likely that perception of exertion at a given exercise intensity may be effected by changes in treadmill grade which in turn influence production accuracy. In fact, the use of grade increments in the treadmill estimation protocol appears to be the only consistent difference in methodology between the present investigation and those that found comparatively greater production accuracy at higher intensities of exercise (5,16,30)." (Dunbar et al, 1992)

Notice how the authors strive to find logical, research based explanations for their findings. This should always be the goal. Sometimes one does not have a firm answer when new findings do not agree with previous work. Still, as in the following example, the author should try to come up with a reasonable explanation.

"We can only speculate as to why production accuracy was lower during the cycle ergometer trials. Although the RPE target was the same for all production trials, several subjects commented that the cycle ergometer trials were more onerous. Perhaps during longer exercise bouts untrained subjects find the localized fatigue of cycle ergometry to be uncomfortable and therefore select a lower workload. This would explain the "underproduction" observed. During the second cycle ergometer trial subjects might recall the discomfort of the first trial and seek to avoid these feelings during the second trial by reducing the workload even further. Previous work has indicated that subjects are capable of accurate production on the cycle ergometer during short exercise bouts (5); perhaps the present subjects were also capable of accurate perceptual regulation of exercise intensity but chose to avoid the discomfort involved. The present subjects were untrained. Whether training (which would increase tolerance for the local fatigue of cycling) would influence production accuracy is an important question for further research." (Dunbar, Goris, Michielli & Kalinski, 1994)

Although the authors could not find a solid, research based answer for why their results differed from what was predicted based on previous work they still attempted to offer a plausible explanation.

References – All statements of fact in your reports should be referenced and the full references listed at the end of the paper. Use an accepted (e.g., APA) reference format and apply it consistently (i.e., use the same format for all references).

APA Reference format: In the body of the report the authors and year of publication are placed in parentheses after the information obtained from the study as shown below.

Example of a reference to a journal article:

The text of your report might look like this:

Distal misplacement of a hand or wrist electrode will influence the estimation of body composition by bio-electrical impedance to a much greater degree than misplacement of a foot or ankle electrode (Dunbar, Melahrinedes, Michielli & Kalinski, 1994).

In the reference list at the end of your report the full reference would be given as follows:

Dunbar, C.C., Melahrinides, E, Michielli, D.W. & Kalinski, M.I. (1994). Effects of small errors in electrode placement on body composition assessment by bio-electrical impedance. Research Quarterly for Exercise and Sport 65(3):291-294.

Example of a reference to a book:
In the body of the report the reference style is similar, with the addition of the page or pages if a specific fact or idea is referenced. Information obtained from a book might be referenced something like this:

Changes in the activity of the enzyme A-kinase vary based on the length of exercise training (Kalinski, Antipenko, Dunbar & Michielli, 1995, p. 64).

In the reference list at the end of your report the full reference would be:

Kalinski, M.I., Antipenko, A.E., Dunbar, C.C. & Michielli, D.W. (1995). Exercise and Intracellular Regulation of Cardiac and Skeletal Muscle. Champaign, IL: Human Kinetics.

*The references for this section follow and are presented in APA format. For your reports choose **one** accepted style and apply it consistently.*

References

Dunbar, C.C., Glickman-Weiss, E.L., Edwards, W.W., Conley, P. & Quiroz, A. (1996) Three-point method of prescribing exercise with ratings of perceived exertion is valid for cardiac patients. Perceptual and Motor Skills 83:384-386.

Dunbar, C.C., Melahrinides, E., Michielli, D.W. & Kalinski, M.I. (1994). Effects of small errors in electrode placement on body composition assessment by bio-electrical impedance. Research Quarterly for Exercise and Sport 65(3):291-294.

Dunbar, C.C., Robertson, R.J., Baun, R., Blandin, M., Metz, K., Burdett, R. & Goss, F.L. (1992). The validity of intra- and inter-modal regulation of exercise intensity by ratings of perceived exertion. Medicine and Science in Sports and Exercise 24(1):94-99.

Information Gathering:

There are many ways to discover what is known about a subject. For undergraduate students textbooks and lectures represent major pathways for gaining information. Undergraduates should also be exposed to the scientific literature. Graduate students are expected to spend a great deal of time reading original research articles.

Let us briefly examine some of the ways in which we acquire knowledge about topics in our field. For scientific purposes some methods of data acquisition are considered more valuable than others. For example, one might have discovered from a personal experience that on a given day 10k running time improved after ingestion of 500ml of a certain sports drink. This bit of information might be considered in the realm of the "case study" or "personal experience". Such observations often lead to important findings, but are of themselves considered very low on the scale of objective information. Whether the improvement in 10k time was related to the sports drink is not clear given the many possible confounders. Perhaps you were more rested on that day. Or it could be that you were dehydrated and the rehydration (as opposed to the sugar or electrolytes in the drink) was the important factor. Maybe the temperature and/or relative humidity were more favorable for that run. Another likely explanation is the placebo effect. If you believed that the sports drink would help then it probably did help. Personal observations are very questionable, but often lead to controlled studies which yield important information. Even more suspect are the unobserved self reports of others. Having not even observed the situation you are even less sure as to what happened.

Another approach is to rely on an "authority". This might involve directly asking an athlete, coach or scientist (often referenced in journal articles as a "personal communication") or by reading something in a textbook or periodical. The opinions of elite athletes, coaches and researchers should be respected and may yield valuable information, yet can be fraught with error. A professional football running back once related how bench presses were an excellent "lat" exercise. Another lineman (who played in the 1996 Superbowl) described how running long distances at a slow pace was appropriate pre-season training for offensive lineman. It seems that both of these athletes excelled in their sport, yet had little understanding of some of the principles involved. Both were remarkable "natural" athletes and did well in spite of their misconceptions about training.

Discovering references to original research articles is a step up the ladder on the scientific information scale. This usually means reading a reference to a study in a book or journal review article. It is expected that the "authority" citing the reference has accurately extracted the information from the article. However, even when facts are referenced in this manner it is still best to read the original article. In this way you are directly reading the researchers report and not relying on a "second hand" summary. Occasionally one will even discover that a reference to an article is in serious error. For example, a textbook in our field referenced a study which was said to prove that squats are "bad for the knees" when in fact the original article reported no evidence of this at all.

In conclusion, the hierarchy for supporting opinions in research would put original research articles published in peer reviewed journals at the top. Review articles by leading authorities might come next. After this, the hierarchy becomes debatable, but textbooks and personal communications by "authorities in the field" might be in the middle, personal observations would be pretty low on the list and the unwitnessed reports of others would likely be at the bottom.

The vast majority of your references for written work in this class should be of original research articles which you have personally read. Use textbooks and reviews sparingly as references and try to avoid personal communications and personal observations.

Literature Searching:

Vast amounts of information are accessible via Medlines and other databases (e.g., Sport Discus). Medlines is probably the best data base for biomedical journals (which includes most of the Exercise Science literature) while Sport Discus is concerned specifically with Sports related topics. The Brooklyn College version of Medlines seems to be much more valuable than our version of Sport Discus for finding Exercise Physiology literature. One must be skilled in properly wording search requests in order not to miss information. It is easy for the beginning user to get the impression that information is not available, when in fact poor search strategies are to blame. Use the library resources and staff to help you through your literature reviews, it will save you a great deal of time!