

Franklin W. Olin College Of Engineering

Special Topics in Bioengineering: Biological Thermodynamics for Engineers  
Spring 2009

MODULE 1 ASSIGNMENT

*Thermodynamics of Human Metabolism*

Issued: Tuesday, January 20, 2009

*Laws of Thermodynamics:*

0<sup>th</sup>: You must play the game.

1<sup>st</sup>: You can't win.

2<sup>nd</sup>: You can't break even, except on a very cold day.

3<sup>rd</sup>: It doesn't get that cold.



<http://www.disasterandstormrelief.com/dfacontact.htm>

**Goals and Objectives for Module 1:**

- Become familiar with the concepts of 1<sup>st</sup> Law of Thermodynamics, enthalpy, calorimetry, specific heat, etc.
- Become familiar with the basics of metabolism of the human body
- Apply the thermodynamics framework you have learned to discussions of human body metabolism through the writing of a technical paper

**Reading:**

- Haynie, Ch. 1 and 2
- Wriggleworth, Ch. 2
- Web of Science
- PubMed

**PART I (due Friday, January 23, 2009 in class):**

The goal of this assignment is to familiarize you with using the resources our Library and other local libraries. You will need the experience acquired during preparation of this assignment when working on your modules. The assignment will not only familiarize you with a very important tools at your disposal, PubMed and Web of Science, but is also intended to develop some skills of investigative digging in the libraries. (HINT: If you are already familiar with these tools, this part should be a breeze.)

You can access Web of Science through Olin library portal. PubMed can be easily found online!

1. Identify and describe differences between the two search engines. What are their objectives? What are their audiences? What are their strengths? Weaknesses? Why would you use one over the other?
2. Using both of the above search engines, find articles by NORDIN M published in 2004 and 2005. Find the articles about low back pain. Write a citation of these articles (like you would on a *References* section at the end of a paper). Use the format of the IEEE Journals to cite the articles, which you should look for under “Guidelines for Authors” on the journal’s website.
3. Pick a topic of interest to you in biological thermodynamics and do a search using both search engines. Start with the most general search possible and get more specific with each successive search. Play around with different search options. Narrow your search in whatever way you like, depending on what is most interesting to you. Your work should be able to be summarized into a Table that looks something like this (but with different key words):

<u>Command</u>	<u>Results (# References)</u>
LUNG and MODEL	15180
LUNG and MODEL and ALVEOLAR SEPTA	56
LUNG and MODEL and ALVEOLAR SEPTA and FINITE ELEMENT	2

Once you have narrowed down your topic through successive search commands, note whether or not the local libraries carry that particular journal either in hard copy or an electronic one.

4. Obtain a copy of one of the articles on your topic of interest and, after reading it, pose a simple research question based on the article. Go to search engines and the libraries and find answers to the question (you may find that no clear-cut answers exist).

**5. PART II (due January 27, 2009 in class):**

The goal of this assignment is to further familiarize you with the art of critical reading of scientific papers. You will need the experience acquired during preparation of this assignment not only when working on your modules but also for the rest of your academic and professional career. The assignment is intended to develop competencies in critical thinking, qualitative and quantitative analysis, as well as communication.

1. Study the assigned reading for this module.
2. Study 2 articles:
  - U. Zurcher, [Human food consumption: a primer on nonequilibrium thermodynamics for college physics](#), *Eur. J. Phys.*, **29** (2008) 1183–1190;
  - M. Ben-Porat, S. Sideman and S. Bursztein, Energy metabolism rate equation for fasting and postabsorptive subjects, *Am J Physiol Regulatory Integrative Comp Physiol* **244** (1983) 764-769. (available at [http://faculty.olin.edu/asieminski/biothermo/biothermo\\_readings.html](http://faculty.olin.edu/asieminski/biothermo/biothermo_readings.html))
3. As you study the papers, annotate each paragraph with a one sentence summary.
4. Come to class prepared to engage in detailed, technical discussion about these papers as well as the relevant thermodynamics contained within them.

**PART IIIa (due January 30, 2009 in class):**

The goal of this assignment is to build on the previous two tasks by:

- Performing investigative literature search on the topics related to *Thermodynamics of Human Metabolism* (e.g., obesity and anorexia), and
- Furthering your skills in the art of critical reading of scientific papers.

The assignment is intended to develop competencies in critical thinking, qualitative and quantitative analysis, teamwork, as well as communication. This is the first assignment you will perform in teams.

1. We have made available a number of papers related to obesity and anorexia (please, see [http://faculty.olin.edu/asieminski/biothermo/biothermo\\_readings.html](http://faculty.olin.edu/asieminski/biothermo/biothermo_readings.html)). As a team, choose one (or more) of these papers for further discussion in class. You may opt for choosing your own paper on the topic of *Thermodynamics of Human Metabolism*. As a team, discuss the paper of your choice. and think about its:
  - general goals,
  - objectives,
  - findings, and
  - significance.Although not required, you may find that writing these things up will be useful during the class discussion.
2. You will find that most of the papers are very interesting, but not particularly technical with regards to thermodynamics. However, there is a great deal of thermodynamics implicitly contained within their approaches and analyses. Relate your paper to the thermodynamics content we have learned to date. As before, although not required, you may find that writing this up will be useful during the class discussion.
3. Come prepared to discuss your paper, and how you will describe and analyze it with respect to thermodynamics, with your instructors.

**PART IIIb (due February 6, 2009 in class):**

The goal of this assignment is to build on the previous three tasks by integrating the quantitative and qualitative knowledge gained to date by writing a technical review paper. The assignment is intended to develop competencies in critical thinking, qualitative and quantitative analysis, teamwork, as well as written communication. This task is performed in teams of three students each. For this first module, we will assign teams.

Based on your chosen paper (s), write a four page technical review drawing upon the thermodynamics concepts we have discussed. Your paper should demonstrate understanding of the underlying thermodynamics concepts (1<sup>st</sup> Law, enthalpy, specific heat, etc.) and how these concepts are used in studying various metabolic processes and/or diseases (e.g., obesity, anorexia). We will discuss your drafts and give you real-time feedback!

When writing your papers, use the IEEE format (word and latex templates provided at [\\Fsvs01\public\+Courses\BioThermo\paper\\_templates\](\\Fsvs01\public\+Courses\BioThermo\paper_templates\)). When constructing the paper, the following links may be helpful: <http://www.ruf.rice.edu/~bioslabs/tools/report/reportform.html>, <http://owl.english.purdue.edu/workshops/hypertext/reportW/generalguidelines.html>, [http://www.techprose.com/webforms/TechWriting\\_Guidelines.pdf](http://www.techprose.com/webforms/TechWriting_Guidelines.pdf).

In general, we are looking for the following content:

- **Abstract:** in no more than 150 words describe general goals, findings, and significance of your work. In general, it is helpful to complete the paper before finalizing your abstract.
- **Introduction:** briefly describe your research question, place your paper within the context of existing literature, explain why this is an important piece of work (why should we care); conclude by describing the layout of your paper.
- **Theory and Discussion:** briefly discuss relevant theory, insert and explain appropriate equations into your text, define all variables, etc. This is a good place to put your theoretical model. Make sure you explain all of the relevant assumptions and simplifications. Discuss how your theoretical model describes the biological system of your choice. State the major findings and relate to previously reported findings.
- **Conclusions:** this is your opportunity to tie the entire together. Briefly summarize your major findings (a “take-away” message), their importance and significance; conclude by describing any potential future directions your work may take.
- **References:** very important. Please, follow the IEEE formatting.

**PART IIIc (due February 13, 2009 in class):**

The final paper is due.