HAPS 2004

Web-HUMAN Exercise- Use as a Teaching Tool

[Revised 6/21 for the 6/16 workshop; also see the newly revised step by step instructions]
Note: This is a text version of the step-by-step instructions actually used in the workshop

The material below is designed specifically for HAPS workshop participants to illustrate how a student lab exercise simulation session can be tailored to stress the cardiovascular, respiratory or thermal aspects of exercise as well as to assess the effects of conditioning and pathology on exercise endurance. A much fuller step by step version of this simulation will be found at the *web*-HUMAN site (http://www.skidmore.edu/academics/human/) by clicking on Help and then looking under the sections "How To Do It" examples and "HAPS 04-Calgary Workshop."

I. Initial Setup (plus an introduction to the web-HUMAN interface)

Pick experiment number 1 & **Run** the subject for 1 hour [1H] with 1 hour between printouts. Use the **Change Table Columns** pulldown menus to set up Column headings as follows:

Time/Day	UNITS
Arterial Oxygen Content (O2A)* [all O2 are typed zero 2]	______
Cardiac output (COL)*	______
Oxygen debt (O2DEBT)*	______
Skeletal muscle blood flow(liters) (MFLOL)	______
Ventilation (VENT)	______
Exercise (EXER)*	______

* Use the **List all variables** option & your Browser's Find and Find Again… Edit menu options to determine units.

II. Running a simulated exercise session (at moderate levels)

We will now have the subject exercise at a moderate level for as long as s/he is able. Exercise sessions require the user to set both the duration and the level (intensity) of the exercise bout.

In the **Experiment Controls** section, mouse **Change Variable** to
- Set the exercise duration (**XERMIN**) parameter for some very large time (100 minutes) This will allow exercise to proceed until some critical, limiting physiological value has been exceeded. (e.g. oxygen debts of > 10L will terminate exercise)

- The level of exercise is controlled by the variable **EXER**, which specifies the level of exercise in O2 usage above the basal level (i.e. rate of O2 used by exercise). Set EXER = to 2.0 L/M (moderate exercise).

- Run your exercise session for 1 hour with 5 min. between printouts. From the output table determine how long the subject was able to exercise for. Try Your 'Patient's Chart' under **Obtain Help, Extra Data or Charts** for an exact report of the exercise time.

III. Consider the physiological response
1) At what time did the exercise terminate and why?
2) Of the 2 parts of the O2 delivery system, the respiratory and cardiovascular, which showed the larger increase and what implications might this have for O2 delivery during exercise? [eyeball 25 min. values]
3) Eyeball cardiac output and muscle blood flow and find evidence for muscle vasodilation during exercise.
4) Why, despite the large increase in lung ventilation, does the blood O2 content not rise appreciably?

IV. Application 2 & 3 - Thermal and Blood Gas Physiology Views of Exercise

The same basic exercise protocol, once mastered, can be used to stress the physiology of systems other than the cardio-respiratory. The following views the same exercise session from the lens of thermal physiology.

Thermal response/ Experiment #2- <Start Over>, **Run** and then **Change Table Columns:** as follows: TEMSET, TEMP, SWETC, SWETV, SKNFLO, BV. **Change Variables** for XERMIN (100) & EXER (2.0) as before. Under **Obtain Help,…** again pick **Your Patient's Chart** and then, as before, **Run** for *25 min.* (25) with 5 min. between printouts. If you wish, under **Graph the latest data** pick column 3(TEMP) and column 5(SWETV), plot the Actual values and hit the **<do it>** button.

Consider the physiological response
1) What pattern does heat dumping by sweating show and why?
2) Why does skin flow increase?
3) Why does blood volume drop?

Blood gas response/ Experiment #3- <Start Over>, **Run** and then **Change Table Columns:** as follows: O2A, O2V, PH, PCO2A, VENT, BLAC. **Change Variables** for XERMIN (100) & EXER (2.0) as before. Under **Obtain Help,…** again pick **Your Patient's Chart** and then, as before, **Run** for *25 min.* (25) with 5 min. between printouts. If you wish, under **Graph the latest data** pick column 5(PCO2A) and column 6(VENT), plot the Actual values and hit the **<do it>** button.

Consider the physiological response
1) Why does a) PCO2A drop? b) O2A rise? c) arterial pH fall?
2) What evidence is there that O2 extraction has risen?

V. Application 3 – Interaction of Exercise and Pathology
HUMAN contains many pathology inducing Variables settings. Here we simulate a consequence of COPD, a reduction in the mean surface area (MSA) available in the lung for gas exchange, & then evaluate its effect on time of cessation of exercise due to accumulation of 10 L O2DEBT.

COPD Exercise Limitations/ Experiment #4- <Start Over>, **Run** and then **Change Table Columns:** as follows: O2A,COL,O2DEBT, MSA,VENT,EXER. **Change Variables** for XERMIN (100) & EXER (2.0) as before and <Go>. Then **Change Variables** *MSA to 30*. Under **Obtain Help,…** again pick **Your Patient's Chart** and then, as before, **Run** for *25 min.* (25) with 5 min. between printouts and hit the **<do it>** button.

Consider the physiological response
1) How compromised is the 70% reduced lung mean surface area exercise time?

IV. Application 4- Factors limiting exercise endurance time
Question- Which part of the cardiopulmonary system is the limiting factor in supplying oxygen to the exercising muscles (that is, why does the model run up an O2DEBT)? Is it due to an insufficient respiratory O_2 intake/ delivery rate or to an insufficient circulatory O_2 transport rate?

Design- To answer this question, try to increase the subject's tolerance (time to 10 L debt) during moderate exercise (EXER=2.0) in *two* ways. First, have him/her breathe 100% oxygen while exercising. This removes as much as possible any *respiratory* restraint. Then, restoring the O2 to its normal value, instead increase the model's basic heart strength (i.e. simulate a cardiac muscle training effect). This 'conditions' the CV system & tends to remove the *circulatory* restraint. Whichever of these maneuvers works best (gives the longer increase in exercise time) indicates that that particular system was the most limiting one originally.

Implementation/ Experiment #5a* - To breathe 100% O2, set the fractional concentration of O2 in the atmosphere (**FO2AT**)[+] to 1.0 (this may be varied between 0.0 <-> 1.0; it is, of course, normally 0.21). Remember to initialize ('Start Over'), **Run** and then reset the Table Columns, substituting O2A as before and <u>substituting **O2V**</u> for EXER (you already know how EXER will behave, when it will turn off, etc.) before you start. Record data as before.

\+ note: here O is the letter "O".

<u>Implementation</u>/ Experiment #5b - <u>To increase basic heart strength</u> (normally = 1.0) you must set the values of right heart strength (**RHSB**) *and* left heart strength (**LHSB**) to higher (yet equal) values. A recommended value is 1.25. (What would happen if you raise the strength of only one side of the heart?!) Use the same Table Columns as in the 100% O2 section above.

<u>Evaluation</u>- Which maneuver, the 100% O2 or the heart conditioning, increased endurance time more? Which system is then normally the limiting one?

*Note: One way to set up an experiment that requires <u>changing 3 variables</u> is to first change two (e.g. FO2AT & XERMIN) and select Go and *then* change the third and finally run the experiment itself.