HUMAN Sample Experiment
Exercise Simulation
(a multiple variable experiment)
(version 15 August, 2011)

All web-HUMAN experiments, like their wet lab counterparts, involve changing one or more parameters and monitoring the response of relevant physiological variables. In a more complex design, more than one parameter is altered. This is illustrated below via creating an exercise challenge.

The user wishes to simulate an endurance exercise bout. Exercise simulation setup requires the user to <u>change</u> the value of <u>more than one variable</u>. In this case both the level of exercise (EXER) and the duration of exercise (XERMIN) must be altered.

1) To begin

To set up HUMAN for exercise and to obtain control pre-exercise values, at the opening screen (see below)

web-Human Physiology Teaching Simulation
(Physiology in Health, Disease and During Treatment)

One click Experiments

You must login to use the One click Experiments.

Login for Personalized Features

Your login name:

Your password:

(Login)

No account? Register for a free personal account.

Start a Physiology Experiment

or

Run a HUMAN Patient.

Welcome to web-Human Version 9.

Resources

About HUMAN- 1st time users

How To - introductory tutorial

Contact Roy Meyers

Credits.

Click

• **Start a Physiology Experiment** (see above, middle)
* always remember that if you wish to Save your experiment you must log in first (above, top)

This results in the typical opening web-HUMAN experiment screen seen below.
Also note that the model is now ready for an experiment to be set up and then run.

DAY/HR	AP	COL	O2DEBT	MFLOL	VENT	EXER
1-12:00 AM	99.78	5.438	0.000	1.100	5.675	0.000
1-12:10 AM	99.69	5.425	0.000	1.089	5.673	0.000

View Output:

AP	COL	O2DEBT	MFLOL	VENT	EXER

Note that in this case (see **View Output:** above) the tables are preset to already contain useful variables for an exercise readout (AP= arterial pressure, COL = cardiac output, etc.)

2) To set up your experiment

HUMAN is now ready to be set up to exercise for one hour with data readouts every 5 minutes. The level of exercise (EXER) will be set at 2.0 Liters/min. of O2 usage above basal and the duration of exercise (XERMIN) will be set at a sufficiently high value (120 minutes) to not terminate the exercise. A snapshot of the final setup occurs below after the following text that describes each of the steps involved in setting up the user control panel.

To set up exercise parameters (duration and intensity)

- Under **Experimental Controls** (see below, lower left)
- Roll down **Choose** under **Change Variable** (button #1) to XERMIN and enter 120 (**Enter New Value**)
- Under **Change Variable** (button #2) roll down to EXER.
- Enter 2.0

To obtain *both* tabular (i.e. text) and graphic output

Under the **View Output:** section (top)
In the **as:** row (i.e. the 2nd row)
Change the output choice from text to graph for the first 5 variables (as shown below)

To begin the actual experiment at the above chosen values

- Under **Run Experiment** type in 1H (H =hours) with 5 (min.) intervals between printouts.
- Click on **<Go>**.

```
 DAY/HR        AP           COL          O2DEBT         MFLOL        VENT          EXER
1-12:00 AM   99.78         5.438         0.000          1.100        5.675         0.000
1-12:10 AM   99.69         5.425         0.000          1.089        5.673         0.000
```

View Output:

| AP | COL | O2DEBT | MFLOL | VENT | EXER |

as: graph   graph   graph   ✓ text   graph   text
                                        graph

Experiment Controls

Help

Change Variable	Enter New Value	Info on Variable
XERMIN	120	10 Minutes
EXER	2.0	0-10 L-02/Min

Help info on: Choose

Tips: How Do I?

View
Variable Value: Choose
Patient Charts or Lab tests:
Choose One

Graph Style   Size: 600
Normalized, one graph

Run Experiment:
for 1H   minutes at 5   minute intervals.

                    Go   Start Over

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3) The output of your experiment

When the tabular and graphic outputs appear, click on the tabular output to bring it to the foreground. The tabular results of the experiment are shown below.

```
   DAY/HR      AP          COL        O2DEBT       MFLOL       VENT        EXER
  1-12:00 AM  99.78       5.438      0.000        1.100       5.675       0.000
  1-12:10 AM  99.69       5.425      0.000        1.089       5.673       0.000
   Duration of Exercise (Minutes)                          =   10.000
   Duration of Exercise (Minutes)                          =   120.00
   Exercise (0. to 10. L-O2/Min) ** Check XERMIN **        =   0.0000
   Exercise (0. to 10. L-O2/Min) ** Check XERMIN **        =   2.0000
   1.00000    Hours  are   60.0000    Minutes
   DAY/HR      AP          COL        O2DEBT       MFLOL       VENT        EXER
  1-12:10 AM  99.69       5.425      0.000        1.089       5.673       2.000
  1-12:15 AM  108.8       17.46      0.5890       13.85       45.35       2.000
  1-12:20 AM  108.1       16.43      2.285        12.79       43.25       2.000
  1-12:25 AM  105.6       15.94      4.374        12.11       46.91       2.000
  1-12:30 AM  103.9       15.74      6.759        11.65       45.87       2.000
  1-12:35 AM  104.0       15.62      9.293        11.45       46.72       2.000
  1-12:40 AM  79.23       11.91      8.462        8.563       27.52       0.000
  1-12:45 AM  77.10       11.25      3.478        8.257       16.00       0.000
  1-12:50 AM  94.48       5.621      0.2725E-01   1.922       26.09       0.000
  1-12:55 AM  95.19       5.110      0.000        1.132       7.844       0.000
  1- 1:00 AM  96.25       5.229      0.000        1.082       6.856       0.000
  1- 1:05 AM  96.83       5.322      0.000        1.077       6.563       0.000
  1- 1:10 AM  97.25       5.389      0.000        1.086       5.967       0.000
```

Graphing selected: Click here if graph does not appear.

Some things to note:

• The model exercised for about 25 minutes (after which EXER returned to zero). The model ceases exercising whenever it runs up a total O2DEBT of greater than 10L (which occurred here at 27 min.)

• The cardiac output (COL) rises but less so, percentage-wise, than the ventilation (VENT).

• At rest about 1/5 of the cardiac output (COL) is being sent to the muscles (MFLOL). As a result of exercise vasodilation, at its peak almost 13/17 of the cardiac output (see 12:15 AM) is directed towards the muscles.

• Arterial pressure (AP) rises only slightly.

4) Graphing Data Outputs in *web*-HUMAN

Now click on the graph window bringing it to the foreground.(The resultant graph may be viewed by scrolling downward below.)
You obtained this 5 variable graph because, in addition to having selected graph as an output form, in the **View** section (see below) you, by default, have chosen a **graph style** (see bottom) that was

- normalized (plots changes in the variable relative to baseline value) and
- a single plot (showing all the variables on one graph as opposed to individual plots)
*for more industrial grade plotting see the instructions in the Manual's Help on How to Graph in Excel

Help

Help info on: Choose ▼

Tips: How Do I?   ▼

View

Variable Value: Choose ▼

Patient Charts or Lab tests:

Choose One   ▼

Graph Style   Size: 600 ▼

Normalized, one graph   ▼

The *results* of this graphing (seen below) confirm that exercise terminates at near 25 min. due to a near 10 Liter total O2DEBT and that Cardiac Output, Ventilation, etc. show a pattern closely following the description above of the Tabular output results.
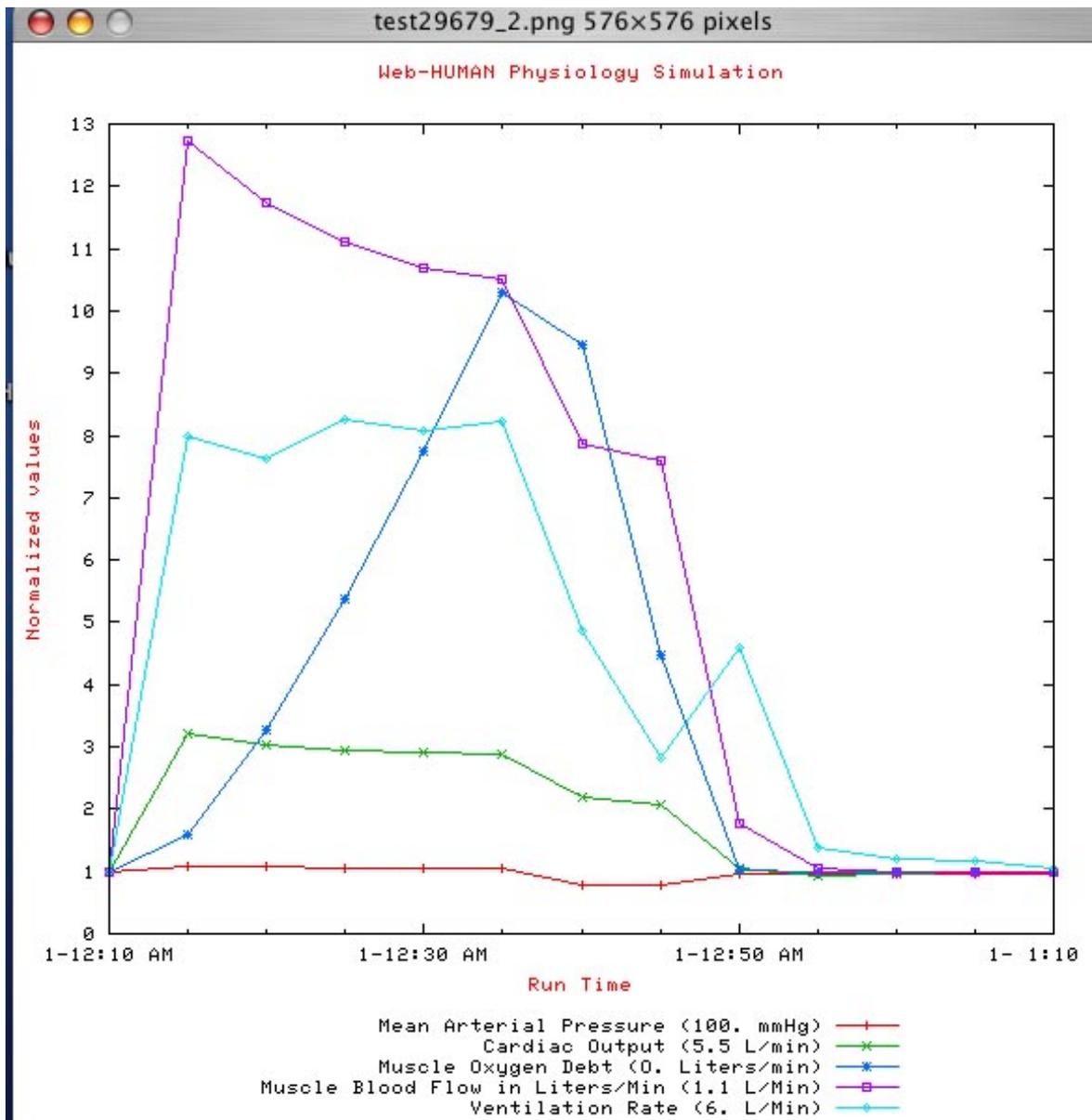
5) Obtaining a Patient Chart profile of a physiological system

A snapshot of the physiology of individual systems at this point in time can be obtained by rolling down the "Patient Charts or Lab tests " option (see below) under the **View** section and selecting the system of interest (in this case the ventilatory system).

```
View
Variable Value:  Choose  ⬍
Patient Charts or Lab tests:
 Lungs and Ventilation Summary  ⬍
```
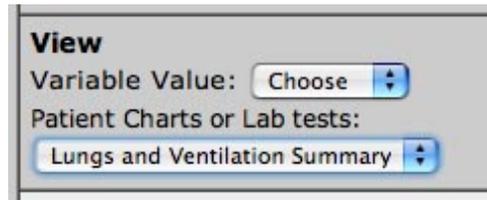
The results of this snapshot in time for the respiratory system (here at 1 hour) follow.

```
$Mr. Norm L. Subject
+        DAY:   1            TIME:   1:10 AM
 This middle aged man appeared to be in good health,
 and had no history of severe illness or hospitalization.
 Your patient is sweating.
 He says:
 I last exercised for    27 minutes.
 My muscles just gave out and I had to stop.
 ............LUNGS AND VENTILATION.............
 Total Ventilation:    6.0  L/Min
       Alveolar Ventilation:   4174.9  Ml/Min
       Tidal Volume:  499.  Ml
       Respiration Rate: 12.   /Min
 Lung Gases -
       Oxygen: 101.   mmHg
       Carbon Dioxide:   39.   mmHg
 Gas Exchange -
       O2 Uptake:   270.  Ml/Min
       CO2 Expired:  214.  Ml/Min
 Arterial: pO2 -   96. mmHg       pCO2 -   39. mmHg      pH - 7.40
```

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6) Some additional possibilities

• Repeat the experiment (use the Start Over option) setting up the tables to study O2 delivery and extraction . Some possibilities for variables are blood oxygen contents (O2A, O2V), partial pressures (PO2A, PO2V), etc.
Note: (To obtain a list of all available variables, call up any Help Info On: <Choose> screen and use the View summary of all variables option).

• Try to get the model to 'run' for 24 hours (EXER = 0.75 yields a stable O2DEBT, set XERMIN > 24H). In addition to gas delivery, water balance, salt balance and body temperature rise must also be dealt with.

• Try to increase exercise endurance by supplying the respiratory system with 100% O2 (see FO2AT - the fraction of O2 in the atmosphere). Try to increase endurance by simulating cardiac conditioning. Cardiac contractility can be raised on the right and left side (see RHSB, LHSB - left heart strength basic). Which maneuver, cardiac or respiratory, yields the

greater increase in endurance and why?

Note: Many of the ideas for this exercise experiment and its variations appeared originally in the Student Manual**
to the microcomputer version of HUMAN written by Dr. James E. Randall, University of Indiana School of
Medicine and Dr. Coleman.

**Coleman, Thomas and Randall, James E. Student Manual. HUMAN-80. <u>Microcomputer Version of a
Mathematical Model of The Human Body In Health, Disease and During Treatment</u>, April, 1981.