About *web*-HUMAN

An overview with
direct links to how-to-do-it Help pages
(version 7.5a, Oct. 7, 2013)

Note well: The major ongoing revisions to this document are now complete.

I. Basic *web*-HUMAN

What is *web*-HUMAN?

Web-HUMAN is an integrative systems physiology *teaching* simulation that presents educators and students

- with *full web access* to Tom Coleman's classic physiology simulation program HUMAN while
- delivering it via an interactive web interface that also provides the user with many additional functional, learning and informational enhancements.

a] The HUMAN simulation- ***what is it?***- HUMAN itself was developed originally as a research tool in the lab of Dr. Arthur Guyton at the University of Mississippi under the direction of Dr. Tom Coleman. It was later refashioned by Dr. Coleman into a teaching simulation.

b] *web*-HUMAN- ***what is it?***- Web-HUMAN was developed for "in-house" use as a physiology teaching tool at Skidmore College with the idea of making the Coleman HUMAN model available to our students via an internet browser of their choice- thus freeing the student and their physiology courses from dependence on any particular hardware, software or physical location.

By being out on the internet and thus open to all, it has become increasingly used by a variety of courses at other colleges, universities and physiologically oriented health professions programs. There, as at Skidmore, *web*-HUMAN is employed in physiology simulation lab sessions, as a lecture/ demonstration tool and as a vehicle for student independent study.

How can I get started using *web*-HUMAN?

Try out the **Introductory tutorial**. This exercise takes beginners step-by-step and screen-by-screen through each of the fundamental skills needed to navigate your way through *web*-HUMAN.

The Introductory tutorial can be accessed
- from this tutorial link [link] and is also available
- on both the opening human page and in the User's Manual.

How do I run an experiment in *web*-HUMAN?

Simulated experiments are run by the same logical protocol used in actual in-the-lab experiments. That is, one changes certain parameters in the preparation and then observes the effects resulting from that change as they develop through time.

a] To initiate a simulated experiment the *user can change* one or more of the some 67 available *variables* via a mouse-click. Thus one might take the model to high altitude by dropping the ambient barometric pressure.

b] To monitor the effects of the user-introduced change, the user "mouses" their choice of output variables of their interest [from among some 140 output variables] and follows the changes in those variables through time.

Thus one might choose to observe the respiratory response to the altitude change by displaying the resulting arterial blood gas sample values (PCO2, PO2, pH, HCO3-) as they change, minute by minute, through time.

A step by step example of such a high altitude experiment can be found via either of the links below.

1-High Altitude: A sample one variable experiment investigating human response to a high altitude (12,500 ft.) environment.[PDF version]

What type of simulated experiments can I run in *web*-HUMAN?

Simulated experiments can be done in a impressively wide variety of subcategories including but not at all limited to the five sample areas listed immediately below.

- **Challenges to standard physiology**- e.g. *exercising* the model at different levels of intensity (O2 consumption) and monitoring the resulting cardiac, respiratory, salt and water balance responses.

  A step by step example of a such a *challenge to standard physiology* (an aerobic exercise experiment) can be found via either of the following links.

  2-Endurance Exercise: A sample multi-variable experiment investigating human response to a simulated exercise bout. [PDF version]

- **Comparative and environmental challenges** – e.g. one might move the model to *high altitude* (decreased barometric pressure) or *thermally challenge* the model by moving it into a high or low temperature environment and observe the related integrated responses to the hypoxia or thermal challenge.

  A step by step example of a such a *comparative physiology experiment* [ascent to high altitude] is linked below.

  1-High Altitude: A sample comparative/environmental physiology experiment investigating human response to a high altitude (12,500 ft.) environment.[PDF version]

- **Clinical challenges** – e.g. one might create pathology* by simulating the *emphysematous aspects* of *COPD* by decreasing available lung surface area for gas exchange. Alternatively one could

simulate *renal failure* by removing a selected proportion of the renal mass from the otherwise still functioning kidney.

Such a *reduction in lung mean surface area* available for gas exchange & its developing consequences are illustrated step-by-step in the experiment linked below.
3-Emphysema: A sample induced clinical pathophysiology experiment investigating long term response to loss of lung diffusion surface. [PDF version]

*Note that in addition to *creating pathology* HUMAN also has built-in *clinical patients* (see below section on Patients).

● **artificial organs** - Testing one's understanding of the normal physiology by attempting to run an **artificial organ** so as to maintain normal levels of systems function. *Web*-HUMAN contains an *artificial heart*, the ability to *artificially ventilate*, a kidney *dialysis* module, the ability to *infuse* electrolytes, *transfuse* blood and more. *

An example of the *use of artificial organ control* in a teaching experiment can be found in the respiratory physiology experiment employed at Skidmore College as linked below.
5- "Experimental Determination of Respiratory Dead Space" [PDF version]

● Testing one's understanding of basic **pharmacologic intervention** – the *web*-HUMAN *Pharmacy* contains a standard basic arsenal of generic vasoactive, cardio active, renal and certain other select drugs. It gives the user the ability to 1] administer pharmaceuticals, 2] adjust their dosage levels and 3] select their frequency of administration.

An example of the *administration of a pharmacologic agent*, norepinephrine, can be found in the web site's Teaching Tutorials Experiments section as linked below.
Norepinephrine Infusion Response (A pre-stored Teaching Tutorial Experiment) [link]

How is the physiological response monitored in *web*-HUMAN?

The response (change in the values of physiologic variables) to a perturbation can be monitored by tracking the output response of variables in both *tabular* and *graphic* in format.

Tabular Output - The default *web*-HUMAN output is a *tabular readout* of the response of the physiologic variables vs. time. In any given experimental run, users can select six from among over 137 user available physiological variables to monitor in the main output table .

The *rudiments* of the user selection of variables for tabular output is covered in the **Introductory Tutorial** cited at the beginning of this document. It can be accessed

- from this tutorial link [link] and is also available on *web*-HUMAN's opening page.

Graphic Output - We also provide the ability to graph the response pattern of up to all six of the variables selected vs. time. The user can chose between *normalized* (change from baseline value) or *absolute value* plot formats and between one combined multiple variable plot vs. many single variable plots.

The *rudiments* of the user selection of variables for both *graphic* and *tabular* output is covered in the **Introductory Tutorial** cited at the beginning of this document. It can be accessed

- from this tutorial link [link] and is also available on *web*-HUMAN's opening page.

More advanced uses of the monitoring of the physiologic response pattern of variables by both graphic and tabular methods can be found in many of the Manual tutorials and examples.

e.g. A fundamental *more advanced set of examples* of the mechanics of the selection and display of variables, both tabular and graphic, occurs embedded in the 3 screen by screen "**How to do it"** experiment tutorials in the (User) Manual and are also linked right here [link].

Can I export data from a *web*-HUMAN simulated experiment to, for example, graph the results in another application?

Yes, data can be exported. For example, the *web*-HUMAN Manual also contains a section with instructions on how to pass data from *web*-HUMAN to *Excel* for a fuller, custom *graphic* analysis.

Exporting data to Excel for graphing or further data massaging [link].

How many physiological systems does *web*-Human contain?

• HUMAN is a *comprehensive systems level* simulation that incorporates *many major sub-systems* -

HUMAN is a (fairly) *comprehensive* model that incorporates the major (systemic) responses of the **cardiovascular**, **respiratory**, **renal**, **acid-base balance**, **thermoregulatory** and **fluid and electrolyte balance** physiological systems and, in addition, contains aspects of responses of the nervous system, the hormone system and muscle/metabolic system.

• HUMAN is a *integrative* systems simulation -

Significantly these individual system responses are ***integrated***. Thus a high altitude challenge (reduced barometric pressure) shows not only the expected hypoxia (low PO2) but also the accompanying hyperventilation, its resultant hypocapnia (low PCO2) , the effect of this hypocapnia on blood acid-base status (a respiratory alkalosis) and the compensation over time via the kidneys (compensatory metabolic acidosis). The effects of this challenge and the response to it by other systems (e.g. the cardiovascular system) are also apparent.

How can I access and manipulate the built-in Clinical Patients in HUMAN?

Web-HUMAN has built into it a *separate section* of simulated **Clinical Patients**.

• User support- These Patients can be examined/studied with (or without) the aid of various levels of Hints in order to arrive at an Analysis/ Diagnosis.

• Range of cases- These clinical 'cases' include heart failure, various types of renal disease, congenital central vascular shunts and more.

• How to access & examine Patients

The [User] Manual's Help screen links below detail

1] the basics of how to access these clinical cases

* Patients Help 1 - The basics: How to access .. [link]

2] and how to utilize the more advanced **Hints & Analysis/Diagnosis** sections that are available in the main Human Clinical Patients table.

* Patients Help 2 - Hints, Analysis/Diagnosis [link]

Also note that many other clinical cases are available in the Save & Retrieve and the One-click sections of HUMAN

II. More advanced *web*-HUMAN - Select additional features

A. Select additional features - On Line Help

In addition to off-line Help such as this document, *web*-HUMAN offers Help on-line [i.e. within the model itself as you are running your simulation].

This Help is of two types. 1] Help on variables - offers extensive cross-linked information on all HUMAN variables 2] Help on how-to-do-it - do wish to take a blood gas sample, administer an infusion, a transfusion, induce pathology, etc. ? The how-to-do-it Help screens give you access to instructions on each of these an quite a few more.

A set of tutorial help pages [from the Manual] on how to access and use On Line Help is linked right here [On-line Help (link)]

B. Select additional features - Save & Retrieve

Web-HUMAN allows registered users to **save & retrieve their simulations** (and those of other users). This less used but rather powerful ability to Save/Retrieve simulations adds *multiple additional possibilities* for users

• **Model storage**- Most obviously, users can *store their current simulation* to be called back at any later time for additional examination or continuation.

• **Sharing models**- They can make their simulation *available to others* [e.g. fellow students, instructors] (at their choice).

• **Folder creation**- One can *create* a *named Folder* [e.g. RSM_HighAltitudeExperiments] into which one's experiments are then stored.

The above save/retrieve capabilities *create* many *new possibilities*.

• e.g. Possibilities for course use- Instructors can **create their own institution's folder space** within HUMAN. This enables much easier pedagogical use of HUMAN by a group of individuals and and also allows for student collaborative simulation work.

• e.g. Availability of a growing fund of pre-stored **one-step, click and run experiments**- these allow instructors and their students to utilize HUMAN without any prior knowledge of how to set the model up.

• e.g. Availability of a wide range of **new sample simulations**- these include 1] new *custom-created clinical cases* ('Patients') 2] *sample experiments* and tutorials and much more.

Help pages on how to utilize the Save and Retrieve capabilities are available via the following link. [Save/Get Help link]

C. Select additional features of *web*-HUMAN - User Manual

Web-HUMAN contains quite a few additional capabilities not detailed above. These, (and some of the material above,) are all available in the *User Manual*.

All simulation pages contain a link to this ***User Manual*** on the upper right of the page being viewed (i.e. Manual). In the Manual users will find many "How to do it" tutorials (including the ones linked above), an extensive analysis of the capabilities of *web*-HUMAN in the "Annotated List of *web*-HUMAN variables and parameters" and much more.

One can access the Manual via its link on each simulation page and also via the following link. [User Manual (link)]

In addition ***examples of teaching labs*** are provided, including all of the original ones from Drs. Randall and Coleman's HUMAN 81 plus ones employed at Skidmore and other institutions. In addition, quite a few other ***sample simulations*** are available here.

Links are available to material used in past *web-HUMAN workshops*, more information can be found about the underlying model itself, its author (Dr. Coleman), the co-author of the microcomputer version (Dr. Randall) and much more.

Bottom line: Anytime you *have a question* or need more detailed knowledge on some aspect of using the model you have *two resources* available.

1] *off-line*- Click on the *User Manual* link at the page top-right

2] *on-line*- Click on 1 of the 2 *on-line Help* links on your simulation page.

A word of caution in using HUMAN – HUMAN is a *teaching* tool

Models cannot contain more than is built into them!* We essentially present, via a web interface, Dr. Tom Coleman's HUMAN physiological model albeit with many enhancements. This simulation was written by Dr. Coleman at a time when the shape of the major behaviors of these particular physiological systems was known experimentally and the interactions between these physiological systems had been characterized. Since this is almost exactly the fundamental physiology that most of us engage in teaching our students, this makes HUMAN a potentially powerful **teaching tool**.

* although they can certainly can yield unanticipated new interactions between systems and be used to test as yet unexplored hypotheses.

On the other hand, this implies certain **limitations**. One should not expect *web*-HUMAN to contain the newer concepts of a more subtle regulatory interplay between system or, for that matter, newer pharmaceuticals developed to address mechanisms discovered after HUMAN itself was written nor the behavior of additional systems not modeled in HUMAN itself.

Those using the web-site to *teach fundamental physiology*, at the pre-professional, college or graduate level, will likely find these limitations of model to be of little or no concern to them since their focus is likely to be fundamental physiology. They should nevertheless keep these limits in mind as necessary.

Contact us if we can be of help!

Use of *web*-HUMAN by the physiology education community has been growing steadily with approximately 100,000 plus non-Skidmore simulation sessions run within the past year. If you have any questions we can help you with or have any suggestions for features you would like to see, please write to me (rmeyers@skidmore.edu) or to Leo Geoffrion (ldg@skidmore.edu) and we will certainly try to get back to you as soon as is feasible within the framework of our schedules.

Enjoy!