

Gas Analysis Programs

Introduction

The enclosed programs calculate pulmonary gas exchange based on ventilation and perfusion parameters and some physiologic data. They incorporate work done over the years by A. J. Olszowka, L. E. Farhi, and J. W. Severinghaus as well as others in an easy to use Excel spreadsheet format. Feel free to use this software as best meets your needs; however, I ask that you refer other interested persons to me for a copy of this software rather than redistributing it yourself.

The Gas Analysis programs, contained in a single template named `Gas_Analysis.xltn`, needs Excel 2011 for the Mac or Excel 2010 for Windows to run. The macro-enabled template should be placed in your Microsoft Office templates directory. These directories are generally hidden from user access on both Macs and PCs.

Mac My Templates Folder

With the Finder activated, press the key sequence `⌘-G`. In the popup labeled “Go to folder:” enter the following string:

`~/Library/Application Support/Microsoft/Office/User Templates/My Templates`

If the folder doesn't exist, then make it. Drop `Gas_Analysis.xltn` into the My Templates folder.

Windows Templates Directory

In Windows, open an Explorer window. In the location bar, enter:

`%APPDATA%\Microsoft\Templates`

If the folder doesn't exist, then make it. Drop `Gas_Analysis.xltn` into the Templates directory.

Note, to use this program, you must enable macros in Excel. You will be prompted when opening the template if macros are not already enabled.

Starting the programs

Mac

From the Excel menu on the Mac, click `File>New from Template` and choose the `Gas_Analysis` template.

Windows

On Windows, click `File>New`. Click the My Templates icon from the Available Templates, then choose `Gas_Analysis.xltn`.

Required Data

This will open an Excel Workbook containing five sheets: Raw Data, Run #1, Run #2, Run #3, Run #4 and a custom toolbar containing five buttons. The button functions are described

below. The Raw Data worksheet is a plain worksheet on which you may copy data and manipulate it in any way necessary. The other worksheets are where the gas analysis programs work. Perfusion and alveolar ventilation distributions may be copied from other files or the Raw Data worksheet, but the units must be in ml/min. The gas analysis programs also require the following information:

1. species,
2. P_{50} ,
3. barometric pressure,
4. body temperature,
5. FI_{O_2} ,
6. hemoglobin, and
7. mixed venous blood composition.

Default values are on the sheets already. The P_{50} default value changes with the species selected. If you wish to calculate inert gas retentions from your measured ventilation and perfusion distributions for comparison with gas chromatography, you must enter the blood:gas partition coefficients (λ).

Program Functions

On Excel 2011 for Mac, you should find the toolbar floating somewhere above the worksheet. In Excel 2010 for Windows, it is hidden in the Add-Ins menu tab. The buttons in both versions have the following functions.

Calculate Blood Gas Compositions

 This button calculates regional and mixed artery blood gas composition as well as mixed venous contents, base excess, mixed alveolar oxygen partial pressure, and alveolar-arterial oxygen difference. Note that the calculated alveolar-arterial oxygen difference is based solely on the ventilation:perfusion distribution and will not reflect any extra- or post-pulmonary shunt. Please see *J. Appl. Physiol.* 85(6): 2344-2351, 1998 for details of how these calculations are made.

Calculate V/Q distributions and Plot Data

 This button calculates the flow weighted end-capillary contents for histogram presentation and the flow- and ventilation-weighted \dot{V}/\dot{Q} distributions similar to MIGET software output. It then inserts a new page named Run #_ VQ Graphs and plots the flow-weighted end-capillary O_2 content histogram, the ventilation:perfusion scattergram, and the flow- and ventilation-weighted \dot{V}/\dot{Q} frequency polygons. This function will also calculate some statistics and display them on the new worksheet. This button will not work if there is already a worksheet named Run #_ VQ Graphs. In order to reuse this function on a data set, the first graphical page created must either be deleted or renamed.

Calculate Mixed Arterial Inert Gas Retentions

IG This button calculates mixed arterial inert gas retentions for the given ventilation:perfusion distribution allowing comparison with gas chromatography. This function requires that the blood:gas partition coefficients be entered in the appropriate cells.

Print Graphics Sheet



This button will print the graphics sheet on one page. It will not work on data pages.

Paste Values without Formulas



This is the paste values button from Excel. If you use formulas in the raw data page to come up with your ventilation and perfusion distributions, this button allows you to paste the values into the Run #_ sheets for blood gas calculations.

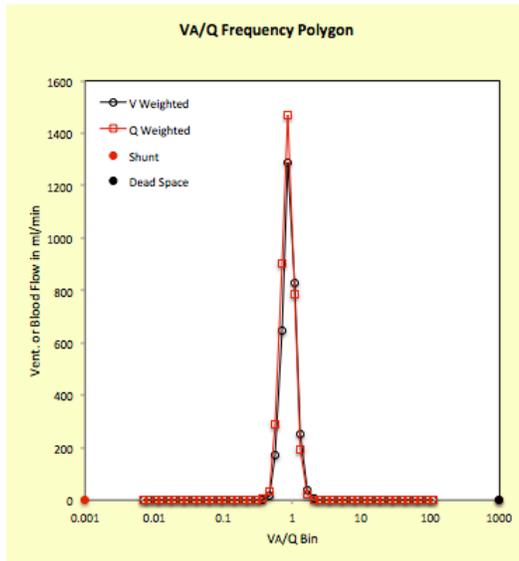
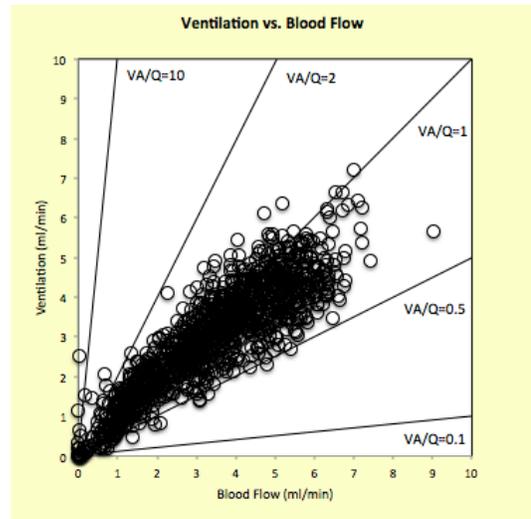
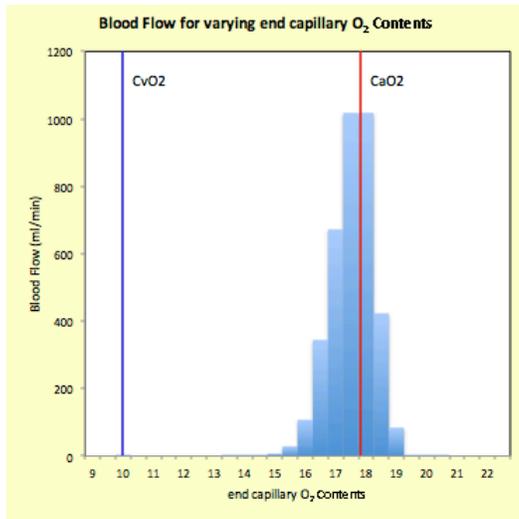
Example

To give you a better feel for this code, this section walks you through some sample data bundled with this distribution. The data look at the effects of hypoxia using 3 runs with decreasing FI_{O_2} (21%, 15%, 9%). Follow the steps below to run the sample data.

1. **Open an empty worksheet** using the Gas Analysis template as outlined in the “Starting the programs” section above.
2. **Load the data file** `SampleVQ.txt` into the Raw Data sheet using `File>Import` from the Excel menu. The file is tab-delimited text and should import easily.
3. **Copy Run 1 into place.** Select the data, excluding the headers, in the columns labeled ‘Q1 21%’ and ‘V1 21%’ from the Raw Data sheet and copy them using `Edit>Copy`. Next, switch to the Run #1 sheet. Select the cell I2 and click the paste values  icon in the toolbar.
4. **Fill in the required physiologic data.** For the sample data, fill in the top portion of Column G on the Run #1 sheet with the data below.

	Run 1	Run 2	Run 3
species	Pig	Pig	Pig
barometric pressure	764	764	764
body temperature	37.1	37.5	37.2
standard P_{50}	35.7	35.7	35.7
FI_{O_2}	0.21	0.15	0.09
Hgb (grams %)	12.4	12.7	12.6
mixed venous pH	7.48	7.38	7.42
mixed venous PO_2	39	37	15
mixed venous PCO_2	46	51	49

5. **Run the Gas Analysis program.** Once the data are in place, click the calculator icon  in the toolbar to calculate the per-piece gas values and \dot{V}/\dot{Q} in columns L through Q.
6. **Plot the data.** Click the plot icon  to finish the calculations and plot a histogram of capillary O_2 contents, a \dot{V}/\dot{Q} scattergram, and the \dot{V}/\dot{Q} frequency polygons. The Run #1 VQ Graphs sheet should look like this:



Statistical Summary

N pieces	1103
VA to Q correlation	0.893
mean VA/Q (from log dist.)	0.884
SD log VA/Q	0.36
Q weighted mean VA/Q (log dist.)	0.857
(from log dist.)	
Q weighted SD log VA/Q	0.185
V weighted mean VA/Q	0.91
(from log dist.)	
V weighted SD log VA/Q	0.243
Calculated Values	
mixed venous O ₂ content	10.21
mixed venous CO ₂ content	48.76
base excess	
arterial pH	7.32
arterial PO ₂	78.1
arterial PCO ₂	44.6
arterial O ₂ content	17.78
arterial CO ₂ content	44.25
alveolar PO ₂	81.2
(A-a)DO ₂	3.1

Help

This is clearly not a commercial product. Nonetheless, I would like to hear about any problems or errors in the software. I am also interested in your opinion about what other analyses may be useful to add to the existing software. Please feel free to contact me.

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