What follows are suggestions for quantitative learning goals that students should have acquired within each year of study. As such subsequent years' courses can build upon this foundation. These are intended to facilitate discussion. What is not presented is a road map to achieving these goals through existing or new courses. We suggest that first agreeing on the outcome, then discussing how best to achieve it may be the most productive path forward.

Year	Quantitative Concepts	Specific Learning Goals	Specific Skills to be Achieved	Possible learning activities
1	Data culture	Students should be comfortable with a culture of 'data' including best practices for data collection, documentation and archiving Students should understand what constitutes evidence and different ways of quantitative understanding. Students should understand the concept of uncertainty in data.	Students should know how to archive and retrieve data from an electronic repository (e.g., gihub, FigShare, dryad) and demonstrate they can attribute (cite) these data properly. Students should be able to describe what is metadata and develop a metadata file for their own data. Students should be able to describe what kind of quantitative data accompanies a particular research project they encounter.	Have students collect their own data to address a problem. They should design their own data collection sheet and create a database along with metadata, for archiving online (ideally, they can re-use this data set in future course work). Give students an easy-to-understand research paper and have them read it and identify what the quantitative data are. Have them think beyond the data as presented in the paper to discuss what the scientists measured, and think about what was *not* measured, and the implications of this.
1	Creating and displaying quantitative information	Students should be able to recognize the different ways that quantitative data are displayed in biology (e.g., scatter plots, box plots, bar graphs, maps,	Students should be able to take simple data sets and create an appropriate graph (scatter plot, bar graph, with error bars) using computer software (e.g., Excel,	Give students simple data sets and have them create different kinds of graphs (line, bar, scatter plot), displaying the variation

		phylogenetic trees, "box and arrow" diagrams). Students should begin to understand and recognize dimensionality of data in graphical display. Students should appreciate the importance of detailed figure captions. Students should be aware of the importance of scale in figures (maps and graphs)	Rstudio, ggplot). Students should be able to make a simple 2-dimensional graph, with uncertainty displayed, and write an appropriate caption. Students should recognize and understand what a log-scale is on a graph.	(error bars) as appropriate. Give students sample figures from peer-reviewed articles and have them scrutinize the caption and figure closely. Have them discuss the dimensions of data shown, the utility of the caption and any uncertainties. Let students graph their own data and write a caption.
1	Interpreting and communicating quantitative information	Students should be able to interpret data presented using figures and/or tables.	Students should be able to translate between words and quantitative displays (e.g., translate text that says "y increased twice as fast with x1 treatment than x2 treatment) into a visual graph and vice-versa. Students should understand the different kinds of trends that data show (positive/negative; linear/non-linear).	Interactive lectures where professor displays a figure (graph, map, phylogenetic tree) and has students write an interpretation; or where professor shows text and students draw a "cartoon" figure.
1	Statistical analysis	Students should develop an appreciation of the importance of statistics in biology. Students should grasp key	Students should be able to recognize where to apply statistical analysis is a simple experimental design. Students should be able to	Give students an easy-to-understand research paper that includes a simple statistical test and have them discuss the importance of

		introductory statistics concepts	define/understand the following terms/concepts: *independent/dependent variable, x/y axis, positive/negative trend, linear/non-linear relationship, mean, standard deviation, normal distributions, sample vs. population, random sampling*	the statistics. Within a research paper and/or lab exercise, have students identify independent/dependent variables, name and describe the trends, talk about the sampling strategy applied.
1	Mathematical modelling	Students should become familiar with mathematical notation, units and the shape of functions. Students should recognize theoretical, mathematical and computation biology as a valid methodological approach.	Students should know that models can be used to test hypotheses. Know that models can be parameterized and predictions validated.	Lab exercise/lecture material. Otto and Day, Chapter 1, discusses the Phillips model for HIV, which showed that the decrease in virions was not necessarily due to the immune responses, it could also be explained by a decrease in susceptible T-cells.
1	Coding/Programming/Software	Students should be aware that there are a range of software packages used to do quantitative work in Biology (R, Excel, MatLab, ArcGIS, Netlogo, Python, etc.)	Students should gain skills in troubleshooting when using software. Students should gain awareness that freeware packages contain extensive documentation (readme files, "Hello World" file)	Guest "mini-lectures" highlighting quant tools used by colleagues in the department. Give students an achievable software-related challenge/problem that they have to solve using online resources.
2	Data culture			
2	Creating and displaying quantitative information		Students should be able to use basic programing to	

			manipulate and visualize data	
2	Interpreting and communicating quantitative information			
2	Statistical analysis	Students should have a working understanding introductory statistics including concepts of probability distributions, Type I and Type II errors, sampling design. Students should understand the importance of experimental design and how decision about experimental design affect statistical analysis.	Students should be able to define/understand the following statistical concepts: *treatment/control, sampling replicates vs. experimental replicate (some areas of biology term these technical replicate vs. biological replication), pseudoreplication, block design, randomized block design.*	
2	Mathematical modelling	Students know types of models, and their strengths and weaknesses.	Know what is meant by agent-based, deterministic, statistical, spatially-explicit, simple vs. complex models, discrete time.	
2	Coding/Programming/Software	Students should have a rudimentary understanding of programing; ability to manage, manipulate, and visualize data.	Students should be comfortable working with spreadsheets Students should develop an understanding of basic programing languages (e.g.,	

			R, python)	
3	Data culture			
3	Creating and displaying quantitative information			
3	Interpreting and communicating quantitative information			
3	Statistical analysis		When given a problem and a range for data, students should be able to independently generate hypotheses, select and execute appropriate statistical tests, and to present results graphically.	
3	Mathematical modelling			
3	Coding/Programming/Software			
4	Data culture		Students should be able to independently ascertain a problem.	
4	Creating and displaying quantitative information			
4	Interpreting and communicating quantitative information		Students should be able to communicate their results with the aid of figures and tables.	
4	Statistical analysis		To address the problem, students should be able to design and execute a means	

			to test hypotheses with a models, simulations or experiments.	
4	Mathematical modelling			
4	Coding/Programming/Software			