GD at a Glance (approximately 7-10 traditional class days after phenomena):

Seg	Model Move	Est Time (min)	Overview	What did we figure out?	Model Ideas Added (Compiled together, these are the model.)
1	P	15-20 many times	We observe one or more phenomena tied to growth and development of organisms in order to motivate the model. The observations occur of the course of a couple of weeks, though short videos and readings can substitute in classrooms with limited time or resources.	We have a phenomenon (maybe two) that will drive us to generate questions about growth, development, and regeneration.	Students compile observations, questions, and initial explanatory ideas that can be leveraged at any point in the construction of the model.
2	P→Q	55	We collect the questions we have from our lab observations of growth and development phenomena or short video clips. After processing some of our questions in small groups, we decide which we would like to take up. Through individual and group sharing, we generate a Driving Question Board and a few Driving Questions we feel capture most of our wonderings.	We have generated a number of questions about growth, development, and regeneration of a multi-celled organism and have a few driving questions that summarize our DQB. We are now ready to begin to address questions about growth.	We now have the questions against which we'll evaluate the model as we move through the unit.
3	Q→M	15-35	We begin to address our driving question(s) by looking at models for growth, problematizing ideas about both unicellular growth and multicellular growth.	We've reminded ourselves that growth primarily occurs through cell division in the organisms we've observed.	Growth mostly occurs because of cell division. Individual cells can grow too (and this is important for single-celled life especially!), but there are limits to how big they can grow. When a cell divides to form two new cells, it gives each daughter cell identical DNA. (Their DNA is also identical to that of the original cell.)
4	M→Q	20	After establishing that all cells in the organism have the same DNA, we ask, how can cells have different forms and functions if they are all genetically the same?	We've reviewed what we know about DNA so that we have the idea that it is the cell's "controller" and that all of our DNA exists in every cell of the body, but we've run into a problem: our cells look very different despite having the same DNA.	[From our model for DNA: DNA is the hereditary material in all cells and it codes for proteins.]
5	P→M	35	Through a series of readings about four or five different cell types in the human body, we come to the realization that our DNA is making different proteins in different amounts in our various cells.	We've realized that cells are different because they have different protein "profiles". This probably has something to do with the genes that make the proteins.	Different cells, however, may contain different proteins or different amounts of proteins. This allows cells to look different (form) and to behave differently (function) from one another.

6	P→M	20	We go back to examine our list of focal proteins from the cell types we just explored and recognize that somehow the genes for these proteins must be acting like switches—on some of the time and off at others.	We've recognized that genes act like a switch and are now ready to consider what might turn them on or off.	Genes work like switches and can be turned on or off.
7	M	55	We explore some of the details of how the "on/off switch" for a gene works, including recognizing the role that signals from both the external and internal environment play in gene regulation.	We've recognized that genes have a switch-like mechanism that is controlled by proteins inside the cells. These proteins bind to genes turning them on or off in response to signals from the external or internal environment.	This process is called "gene regulation" or "gene expression" and is controlled by signals from the cell's (or organism's) environment.
8	Q→M	110	We apply our understanding of growth and development to our questions around regeneration. What can we explain and what can we not explain? We can easily recognize the process by which regeneration occurs, but we DON'T understand under what conditions an organism can regenerate whole parts, limbs, or even whole organisms.	We have a finalized model for growth and development that helps us explain regeneration as well. We've checked back over our Driving Question Board to at least acknowledge which questions are still lingering, understanding that even our complex model is incomplete.	Cell division allows organisms to regenerate tissue, but most cells can only produce the same kind of cell. Once cells have differentiated, they have a determined cell fate and so do their daughter cells. Special cells, called stem cells, do not differentiate and can become any cell type. (Some cells partially differentiate. They are kind of like stem cells and can become lots of different kinds of cells, but not every kind of cell—e.g. bone marrow cells.)
9	M→P	55	We apply our model to a novel phenomenon. We have not considered development across the life cycle where organisms take on very different forms. Can we use our model for growth and development to explain metamorphosis of a caterpillar to a butterfly?	We have applied our model for growth and development to the phenomenon of a caterpillar becoming butterfly with a whole new body plan mid-life. We've seen that our model at least partially explains how and organism might reorganize itself during the process of metamorphosis.	