

# Handbook for Teachers

## Curriculum for Translating Translation and Scientific Questioning

*Engaging Students in Translational Biomedical  
Science and Research*



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# Project Overview

We have been inspired to develop this Translating Translation and Scientific Questioning program and curriculum as a way to share with you and your students the excitement, learning adventure, and extraordinary success of a workshop series developed at the University of Arizona by Professor of Surgery Dr. Marlys Witte and her colleagues. The seven-week workshop, which is offered every summer, has the startling title, “Summer Institute on Medical Ignorance” (SIMI); and it consistently emboldens students to ask questions that express their inherent curiosity and can lead to meaningful research.

This unique program champions ignorance – the kind that leads to authentic, original questions. The kind that Nobel physicist David Gross called, “our most important resource” and “the most important product of knowledge.” The kind that Nobel physicist Richard Feynman said he felt a responsibility to “as a scientist who knows the great value of a satisfactory philosophy of ignorance, and the progress made possible by such a philosophy, progress which is the fruit of freedom of thought.” This is the kind of ignorance that ignites fresh, imaginative thinking and is the springboard to discovery.

We hope that this curriculum will inspire and excite you, and will nourish our upcoming young thinkers by nurturing and sustaining their innate curiosity, their questioning minds, and their ignorance. Once you have seen what we mean by extolling the virtues of this seemingly very negative word and have reviewed this guide to incorporating a philosophy of ignorance into the science curriculum you teach, we hope you will honor and reward your students for their willingness to embrace ignorance by asking questions, rather than repeating or producing answers. What they ask might not only lead to new knowledge and insights we cannot yet imagine – they might also lead to unimagined solutions when translated and applied to real-world issues such as in medicine.

Our overarching goal is to promote student curiosity, motivation, skills, networking, and career pathways in science, particularly to reinvigorate the clinical research enterprise. But the importance of recognizing and dealing with ignorance applies to all authentic inquiry. Long-term outcomes document that our face-to-face “ignorance-based” science education approach and teacher training components reinforce the “joy” of learning, creativity, and sense of adventure sparked by questioning the unknown.

*Ignorance is the kind of not knowing that comes from insight and leads to insight. That insight - the one it comes from and the one it leads to - is the discovery that there is a world far larger than the one that is known, one that (whether we know it or not) shapes all our knowns. It is a world we know nothing about, though if we search we can catch glimpses of it. Ignorance is the not knowing that opens us up to philosophical wonder, to scientific discovery, to human wisdom.*

– Gerald Nosich, PhD  
Professor of Philosophy, University of Buffalo



# The Curriculum: Translating Translation And Scientific Questioning

**M**ost science classes focus on the scientific method: formulating tractable research topics, developing experiments to test those hypotheses, and making inferences based on the outcomes of those experiments. But our program and its companion web-based platform-grid the Virtual Clinical Research Center and Questionarium (VCRC/Q) focuses on two complementary topics or themes: Where we find good questions to pose for research purposes, and – once we have completed a round of basic research – how we translate the knowledge and insights we have gained into end-points that address real-world issues and solutions that make a difference in the lives of others.

Our experience has shown how crucial it is for students to understand that the best questions come from their intrinsic curiosity about the world and to realize that basic research which remains trapped in the laboratory may end up as little more than a self-satisfying exercise for the investigator. We therefore focus on encouraging students to love science and to want to engage in pro-social outcomes of their scientific explorations. Teaching this philosophy of research and these skills form the basis of the two-part curriculum we present here: the Translating Translation and Scientific Questioning Curriculum (TT/SQ)

To facilitate your students' learning process, this site and the VCRC/Q website will serve as dynamic and evolving repositories of biomedical research. Currently, this site maps the status of the Translating Translation and Scientific Questioning curriculum; and it will serve, upon its final launch, as an introductory

outline for teachers. We invite you to check in regularly to view its progress and then become a contributor together with your students.

Throughout the curriculum, we provide and rely upon the following supportive materials and resources, which are sometimes presented in a variety of sequences to match the teaching needs of each segment:

**Teacher Information** – Background reading or foundational material that supports the key concepts of the section and provides a context for the exercises and projects that follow. Some of the teacher resources we provide – especially videos – might be interesting and thought-provoking for your students. We encourage you to share them at your discretion, and have already included a few in the resources for classroom exercises and discussion. We also encourage you to share with your students any of the quotes about science that you think would inspire or interest them. And encourage them to contribute their own.

**Narrative** – A written outline of the curriculum that we give our students at the University of Arizona. It is not a script to be read to them – it simply conveys some of our thoughts about the ideas we cover and they become immersed in during our seminars and their research experience.

**Class Exercises** – Designed to help students feel confident about asking questions in front of their peers, who tend to equate questioning with not being smart. The focus of the curriculum always remains on Albert

Einstein's learning philosophy: "The important thing is not to stop questioning." To facilitate this kind of learning, exercises include handouts that have been refined over the years by the Summer Institute on Medical Ignorance conducted at the University of Arizona.

| **Video Resources** – Segments of videos to spark student engagement and discussion. We and our students have created many videos during past seminars and workshops, and these samples are available to you and your students. We have also been given permission by TED Conferences, LLC, to incorporate relevant segments of video presentations from TED Talks. Finally, the curriculum teaches students to produce their own videos as a final project – one of many forms such a project can take. Our experience supports the idea that one of the best ways to learn a topic is to construct a final project that teaches others; and allowing students a choice of formats, from a video presentation to poster sessions, gives them freedom of choice.

**Web Links** – While the web provides a huge repository of data that can become useful information when individuals apply it, not all sources of information on the web merit consideration. So part of the curriculum addresses web literacy. Other links will take your students to interesting, fun sites that complement and reinforce key concepts of the curriculum, such as Crash Course videos on YouTube (if you find those sites appropriate). The goal of this project is to make the entire curriculum available within a web-based environment, so that students anywhere can appreciate why questioning is the key to scientific progress, and become excited by the opportunity to ask what they wonder about.

The material below describes the underlying curriculum that will be made available. When it is ready for public beta testing, the online

version will also be available here at the Medical Ignorance website. In addition, relevant state standards will be posted and updated as needed.

## The Questioning Theme

Since the heart of this project is our conviction that students must become intrigued by science in order to engage in it, it is essential for us to stimulate and foster their curiosity. Over the years, our primary investigators and staff have demonstrated that teaching students to ask questions about their worlds piques their interest and leads to better, more tractable research questions. The Questioning Curriculum presents an outline of suggested activities for you and your students. Teachers with a wide variety of teaching styles and the need to comply with local course requirements consistently come away from our seminars at the University of Arizona convinced of, and committed to, the basic idea that science only advances through asking questions, and that questioning skills can be refined in the classroom.

## What's This All About?

Although most teachers appreciate that students must be curious if they are to become engaged in science, encouraging scientific curiosity is not generally a mainstay of curricula in middle or high schools. Teachers are faced with so many demands to cover the material required for standardized tests that they cannot individualize the curriculum according to each student's interests. But recent standards implementations emphasize the roles of inquiry and questioning. This curriculum is therefore designed to provide you with some ways to incorporate these valued skills into existing science curricula.

Our goal is to create a learning environment that is safe for questioning and incorporates



the curriculum and technology students have grown up with, including social media, computers, and mobile devices. But we want to emphasize that the fundamental principles of this curriculum can be shared in any classroom, with or without technology.

### Teacher Information

1. Video on the role of technology in engaging students in scientific inquiry. – 2:21 minutes  
<http://www.adobe-creativity.com/HED/>
2. Background information on encouraging students to formulate questions.  
<http://hepg.org/hel/article/507#home>
3. Video by Sir Ken Robinson: How to escape education's Death Valley (and the irony of "No Child Left Behind") – 19:11 minutes  
[http://video.ted.com/talk/podcast/2013S/None/SirKenRobinson\\_2013S-480p.mp4](http://video.ted.com/talk/podcast/2013S/None/SirKenRobinson_2013S-480p.mp4)
4. "Creativity And Why It Matters" – published by Adobe Systems – 22-slide PowerPoint  
A study of professionals presents stunning findings on their views of creativity.  
<http://www.images.adobe.com/www.adobe.com/content/dam/Adobe/en/education/pdfs/adobe-creativity-education-findings.pdf?trackingid=KEVTN>

*Curiosity is the engine of achievement.*  
- Sir Ken Robinson

### Narrative

*Every time I hear of a new invention or a new cure, I wonder, "What led up to that? How in the world did they discover that?" For instance, how could someone ever figure out that giving people small doses of the polio virus could actually help eradicate polio?*

*Most inventions and discoveries begin with basic questions. Curiosity, imagination, and confusion all lead to questions that we could*

*pursue the answers to. And the questions are often quite simple - they are why, how, when, and where questions.*

*As I hope you'll see, asking questions is the very first step in scientific research and discovery. And we'll be spending more time than most science classes talking about questions, including what kinds make for good research.*

*When Richard Feynman, the Nobel Laureate quoted in the Overview, was a graduate student at Princeton, he was so curious about other fields that he asked to sit in on some of their classes. Before his first class in biology met, the guys who had invited him to take the course wanted to show him some things under a microscope. As Feynman describes it:*

*They had some plant cells in there, and you could see some little green spots called chloroplasts (they make sugar when light shines on them) circulating around. I looked at them and then looked up: 'How do they circulate? What pushes them around?' I asked.*

*Nobody knew. ...it was not understood at that time. So right away I found out something about biology: it was very easy to find a question that was very interesting, and that nobody knew the answer to.*

– From Surely You're Joking, Mr. Feynman; 58

Unfortunately, some people are intimidated by science. They think it's difficult. If you happen to be one of those people, remember that the natural world we live in is the most awesome mystery there is. So just think of yourself as a detective (or as an explorer, if you prefer) who notices things in your daily life that puzzle you or grab your attention. You are on the lookout for evidence of some mystery – or some new territory – and you want to explore and understand it. It's a great way to approach science and have fun with

this class. And the less you take for granted what you see in the natural world around you or accept without question what anybody else has told you, the more interesting your questions are likely to be. When you watch the video coming up, think of how simple Feynman's question is about the ball and the wagon. Just step back and really look at what you see - and really see what you look at.

### *Class Exercises*

#### **How would you define the word “question”?**

If you had to explain to a non-native English speaker what question means, and you were pretty sure they didn't have a word that directly translated the idea, how would you explain it? Really think about it.

Possible definitions:

1. “A sentence worded or expressed so as to elicit information.”  
(<http://en.wikipedia.org/wiki/Question>)
2. “Something that is asked.” – from Webster's dictionary

### **| Video Resources**

1. Can a focus on questioning really make a difference? Ideas come from asking questions. Adam Savage tells a good story about Richard Feynman asking why a ball rolled to the back of a wagon when he began to pull it. 7:32 minutes; suggested excerpt: 0:00 - 1:24 minutes Excerpt [http://www.ted.com/talks/how\\_simple\\_ideas\\_lead\\_to\\_scientific\\_discoveries.html](http://www.ted.com/talks/how_simple_ideas_lead_to_scientific_discoveries.html)
2. Video by Sir Ken Robinson: How to escape education's Death Valley (and the irony of “No Child Left Behind”) – 19:11 minutes  
[http://video.ted.com/talk/podcast/2013S/None/SirKenRobinson\\_2013S-480p.mp4](http://video.ted.com/talk/podcast/2013S/None/SirKenRobinson_2013S-480p.mp4)
3. “Creativity And Why It Matters” – published

by Adobe Systems – 22-slide PowerPoint  
A study of professionals presents stunning findings on their views of creativity.

<http://www.images.adobe.com/www.adobe.com/content/dam/Adobe/en/education/pdfs/adobe-creativity-education-findings.pdf?trackingid=KEVTN>

### **The Wonder of Ignorance ≡ Curiosity**

The quote below expresses beautifully what we mean when we applaud ignorance, and what we hope to help restore to the science classroom through this curriculum.

*Ignorance is excitement, the perpetual challenge to grow. Ignorance is everything yet to be: places you've yet to go; people you've yet to meet; facts you've yet to learn; things you've yet to discover. Ignorance is viewing the world through the eyes of a child for whom all is fresh, new and unexpected. Ignorance is the possibility of surprise.*

– Robert Root-Bernstein, PhD  
Professor of Physiology  
Michigan State University  
Mac Arthur Foundation "genius"

### **Teacher Information**

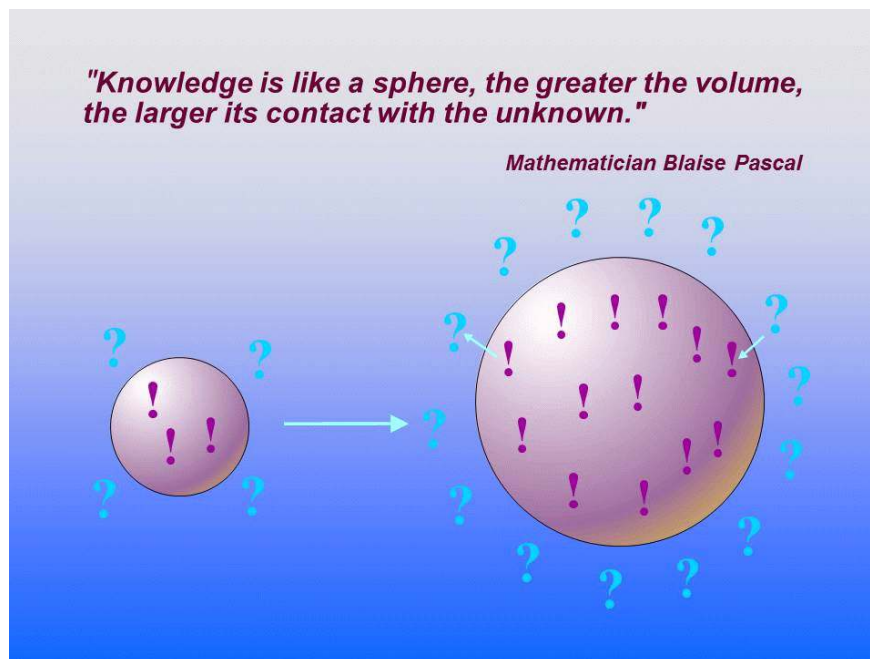
1. Medical Ignorance website at the University of Arizona.  
<http://www.medicalignorance.org/>
2. Stuart Firestein Ignorance website at Columbia University.  
<http://ignorance.biology.columbia.edu/firestein/>
3. A compilation of brief answers from 150 people, from all walks of life, about what makes them curious.  
<http://curiosity.discovery.com/question/what-makes-you-curious>

## Narrative

*“Ignorance” can have very negative connotations, like stupid or dumb. But that’s not what I mean when I use the word. In fact, inspired by her NYU medical school mentor, physician-essayist Lewis Thomas, Dr. Marlys Witte has spent the last 30 years teaching medical ignorance and celebrating its importance in advancing science. Dr. Witte is a Professor of Surgery at the University of Arizona’s College of Medicine, and is Director of its Medical (and other) Student Research Programs. She has gained an international reputation as an expert in lymphology (lymph, lymphatics, lymphocytes, and lymph nodes in health and disease) and, with her husband surgeon Charles Witte, has authored more than 400 peer-reviewed publications. An international educator, she has been dubbed the “ignoramamama” – founder of the Curriculum on Medical (and other) Ignorance – a global multidisciplinary movement to recognize and deal with “what we know we don’t know, don’t know we don’t*

*know, and think we know but don’t.” As she says, “ignorance – i.e., unanswered questions and unquestioned answers – is the raw material of knowledge, and (current) knowledge is the raw material of (future) ignorance, i.e., answers and questions shift with time and the accumulation of answers.” Simply stated, ignorance is the domain of all we have yet to learn and discover.*

*None of us has the answers to all or even most questions in any domain of science – and just think of the infinite number that have yet to be asked. We’re very ignorant about lots of things, and the more you embrace ignorance, engage in curiosity, and enjoy the questions you ask, the more fun you’re going to have with science. And the more knowledgeable you will become because as 17th century mathematician Blaise Pascal envisioned, “Knowledge is like a sphere – as it enlarges so too does its contact with the unknown” (Figure 1) – that is, the more you know, the more you recognize that you do not know!*



**Figure 1.**

**Reference:** Witte, M, P Crown, M Bernas, F Garcia: “Ignoramics” in medical and premedical education. J Inv Med 56: 897-901. This article reviews the evolving concept of ignorance in general and in medicine and its relationship to knowledge. Goals, content, and assessment of such ignorance-based courses are discussed. Ignoramics and questioning is a way to balance the information-overloaded science/medical curriculum.

### | Video Resources

1. A compilation of brief answers from 150 people, from all walks of life, about what makes them curious.  
<http://curiosity.discovery.com/question/what-makes-you-curious>
2. Dr. Marlys Witte talks about her experiences when she decided to teach a course on medical ignorance. 18:04 minutes; several relevant excerpts Sample Excerpt  
<http://www.youtube.com/watch?v=u3SGNvMcNdI>

### *Class Exercise*

#### **How would you define the word “ignorance”?**

Before discussing the topic, ask, “What comes to mind when I say someone is ignorant?”

What are the connotations? Why do you think it has those associations?”

Think of examples where you ignorance helped you - and where it harmed you.

Discuss the different dimensions of ignorance.

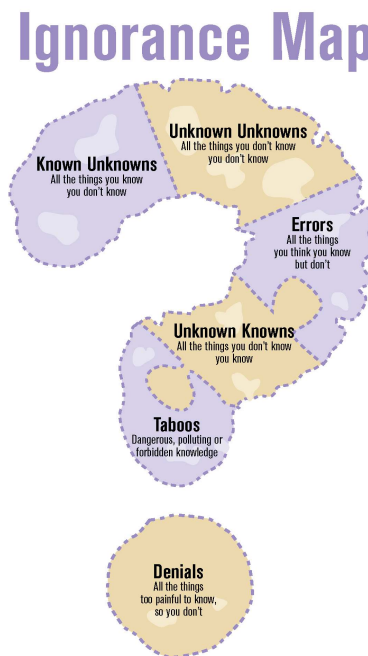
How does the "information gap" relate to curiosity?

#### **The Ignorance Map**

Hand out our map of the domains in the land of

ignorance (Figure 2 ) and stimulate a brainstorm discussion of the types of questions that would fall into each category of the map in general or in a specific discipline of study.

### The Ignorance Map



### Attention and Perception

Observation is often identified as the first step of the scientific method. But criminal trials and our own experiences have taught us that not everyone observes the same thing when they look at the same scene. In fact, it is not uncommon for any number of people who witness the same event to see it differently. Why is that? Nobody knows all of the reasons, which range from psychological to physiological. But a simple way to think about it is that different things interest different people, and those are the things that draw our attention. Some examples of differences in perception are provided in the readings and videos below.

## Teacher Information

1. The role of visual perception in attention – from the Scientific American.  
<http://www.scientificamerican.com/article.cfm?id=the-role-of-visual-attention>
2. An autistic man whose perceptions are woven together to produce a very different understanding of the world. A good example of just how really different people's perception can be. – 10:54 minutes  
[http://www.ted.com/talks/daniel\\_tammet\\_different\\_ways\\_of\\_knowing.html](http://www.ted.com/talks/daniel_tammet_different_ways_of_knowing.html)
3. “Parallels between Perception without Attention and Perception without Awareness” – a scholarly article.  
<http://www.arts.uwaterloo.ca/~pmerikle/papers/Merikle.ConsCogn.1997.pdf>
4. “A Boolean Map Theory of Visual Attention” – from the Learning Perception and Attention Lab  
[http://www.pashler.com/Articles/Huang\\_Pashler\\_PR2007.pdf](http://www.pashler.com/Articles/Huang_Pashler_PR2007.pdf)
5. Attention arises through a host of complex processes that contribute to consciousness itself. – 55 PowerPoint slides  
[http://www.csun.edu/~vcoao0el/de361/de361s104\\_folder/sld002.htm](http://www.csun.edu/~vcoao0el/de361/de361s104_folder/sld002.htm)
6. Movie perception test video by the makers of the Invisible Guerilla – 2:10 minutes  
[http://www.youtube.com/watch?v=6JONMYxaZ\\_s](http://www.youtube.com/watch?v=6JONMYxaZ_s)

## Narrative

*Nobody knows all of the reasons why everyone sees things differently. Reasons range from the psychological to the physiological. But a simple way to think about it is that different things interest different people, and those are the things that draw our attention. Some examples of differences in perception are provided in the reading and videos below.*

*Where do you think questions come from? It*

*may seem like we're over-analyzing a very simple concept. But let's think about it. What if we didn't have all the senses we have? What if some of our senses are not as keen as those of our friends? We all have different backgrounds and assumptions that have come about because of how we grew up. Our parents might have taught us much of what we assume to be true about the natural world. Do you think all parents explain the world in the same ways? We are also influenced by friends. If a good friend of yours tells you someone else is a jerk, won't you be influenced by that?*

*Then what happens if you hear or experience things that don't match the assumptions you've made? Ever wonder why someone else feels cold when you feel warm? Get surprised when you find out something works totally differently from what you were told?*

*One thing that creates questions in our minds is trying to explain surprises in the world around us. What we perceive, what we hear, smell, taste, and feel. And we are even more likely to have questions when what we perceive contradicts expectations about our world - when something goes against what we've learned or seems odd because it's different from what we assume. What interests me might not interest you. But what's fun about good science research is that, within reasonable constraints, you get to ask questions about things that interest you or strike you as odd. And I'm going to encourage you to question, question, question, until you find an interest you want to pursue.*

*So let's step back. What I'm saying is that observation - using all your senses - is always the first step in coming up with questions that will interest you. And since we want you to be interested in something that is important to you, we need to talk a bit about attention, perception, and observation.*



*First, you have to bring to your attention what you notice – you have to notice that you’re noticing. Focus on it and become fully aware that you are paying attention to this thing. The more open-minded you can be and approach it with wonder instead of any judgment you’ve been told to make about it, the more open your mind and eyes will be to seeing it in new ways, and the fresher your perspective will be.*

### **Class Exercise**

Have the entire class observe something together, and ask them to jot down everything they notice. What they observe could be as simple (and complex) as a flower or a kitchen tool. Ask them to try to look at it like they’ve never seen it before (maybe they haven’t). What strikes them about it? What do they think the different parts of it are for? Does anything surprise them or seem mysterious? Is there anything they feel they don’t understand about it? Of all the things they observe, what interests them most, and why? What question(s) do they have about it?

Allow ample time for them to share their responses to observing “the same” thing and let them discuss the similarities and differences, as well as any questions they have. Focus on having each student share what interested them most, and explain why. Then follow up with the video resources.

### **| Video Resources**

1. Gavin Pretor-Pinney: Cloudy with a chance of joy talks about overlooking the commonplace. 10:54 minutes (many excerpts or entire presentation)  
[http://www.ted.com/talks/gavin\\_pretor\\_pinney\\_cloudy\\_with\\_a\\_chance\\_of\\_joy.html](http://www.ted.com/talks/gavin_pretor_pinney_cloudy_with_a_chance_of_joy.html)
2. Illusions that make us question our ability to see objectively. 14:36 minutes (many excerpts could be used)  
[http://www.ted.com/talks/al\\_seckel\\_says\\_our\\_brains\\_are\\_mis\\_wired.html](http://www.ted.com/talks/al_seckel_says_our_brains_are_mis_wired.html)

3. Video about perspective, produced by the Physical Science Study Committee. In many ways, the introduction to theories of special relativity is demonstrated in this 1960 film. 13:21 minutes (many excerpts could be used)  
<http://www.youtube.com/watch?v=pyBNImQkRuk>
4. Pass-the-basketball selective attention test. A fine example of how we tend to see what we want to see or are told to focus on-and how, because of that, we might miss other things. – 1:22 minutes.  
<http://www.youtube.com/watch?v=vJG698U2Mvo>
5. Movie perception test video - Did you really see what you saw? – 2:10 minutes.  
[http://www.youtube.com/watch?v=6JONMYxaZ\\_s](http://www.youtube.com/watch?v=6JONMYxaZ_s)

### **Fact Or Fiction: Scientific Truth**

Scientific knowledge is constantly in flux, so it can be misleading to claim that there are scientific facts. It might be more constructive to think of scientific knowledge as our best understanding, to date, of the natural phenomena we know about.

The discoveries of quantum mechanics provide an excellent example of this. While Einstein’s theory of relativity was generally accepted as fact by the scientific community, the astonishing and seemingly bizarre findings and questions that have emerged from quantum mechanics – about how sub-atomic particles behave – call into question the physical laws that had been the very foundation of physics. What was thought to be known and predictable, based on the truth of those laws, has been so deeply shaken that Einstein spent his last years trying to find a way to reconcile the contradictions.

### **Teacher Information**

1. Video on the half-life of facts. – 12:01 minutes  
<http://www.youtube.com/watch?v=GaxYnvd7YAM>

2. Change in knowledge is inevitable because new observations might challenge prevailing theories.

<http://www.project2061.org/publications/sfaa/online/chap1.htm>

3. Paleontologist Jack Horner describes astonishing new findings about dinosaurs that drastically shift our understanding. Great story. – 18:23 minutes

[http://www.ted.com/talks/jack\\_horner\\_shape\\_shifting\\_dinosaurs.html](http://www.ted.com/talks/jack_horner_shape_shifting_dinosaurs.html)

## Narrative

*Appreciating the fact that we can be easily confused about the world around us will probably increase the number of questions you have about your world, science, and nature. And your questions are likely to be different from my questions, because different things interest each of us, as we discussed. But if you're willing to ask questions, including questions that you used to think were dumb, you might become the next great scientist - simply by looking for answers to your own unique questions. That's why you might have heard some teachers say, "There are no dumb questions." That's not just a polite way of encouraging you to feel better about yourself - it's the truth. As I mentioned before, who would have ever thought it would be smart to ask, "I wonder what would happen if we injected the polio virus into people?"*

*I know that many of you feel like it's difficult to ask questions, especially in class. Somebody might think you're dumb, or you might be shy and don't want to draw attention to yourself. But science is only possible if each of us questions the world around us, including things we think we know, things people won't tell us, and things that seem impossible to know.*

*Even if you aren't interested in becoming a scientist, learning to ask questions is not only fun and interesting – it can also help you to get jobs in related fields that you might want to explore. For example, if you ask questions about epidemics or medical breakthroughs that occur, or you learn about the process that the medicines in Walgreens went through, it can help you in unexpected ways in the future.*

*So here's another excerpt of a talk by Dr. Beau Lotto, a neuroscientist, where he encourages you to question your accepted notions, and illustrates how the quality and enjoyment of science will increase.*

## | Video Resources

The class discussion that follows is based on the presentation below, in which Lotto thinks all people (kids included) should participate in science and, through the process of discovery, change perceptions. It also illustrates the exhilaration that comes from exploring the unknown. 16:31 minutes; many excerpts could be used.

<http://tinyurl.com/d5wvg2z>

## Class Discussion

What do you think of Dr. Lotto's assertion that good science is brought about by asking questions, often about things we think we already understand? What do you think of the idea that play is similar to conducting scientific inquiry? Does that work for you? Does the analogy fall down anywhere? Would you add additional points to Dr. Lotto's list below, or qualify it somehow?

- o Celebrate uncertainty
- o Adaptable to change
- o Open to possibility
- o Cooperative
- o Intrinsically motivated

## Asking Questions Can Challenge Assumptions

Asking questions that surprise people, because the answers seem so obvious to them, can lead to a contradiction of their expectations, good and bad. When you question what people believe in, surprising things can happen.

### Teacher Information

1. Challenging assumptions in education. – From Natural Life Magazine  
<http://www.naturallifemagazine.com/0006/assumptions.htm>
2. How the opposite of our assumptions might also be true. – 2.42 minutes  
[http://www.ted.com/talks/derek\\_sivers\\_weird\\_or\\_just\\_different.html](http://www.ted.com/talks/derek_sivers_weird_or_just_different.html)
3. An economist re-examines the statistics on AIDS in Africa and concludes that everything we know about the spread of HIV on the continent is wrong. – 15:38 minutes  
[http://www.ted.com/talks/emily\\_oster\\_flips\\_our\\_thinking\\_on\\_aids\\_in\\_africa.html](http://www.ted.com/talks/emily_oster_flips_our_thinking_on_aids_in_africa.html)
4. Thinking Critically – Community Toolbox – The University of Kansas  
[http://ctb.ku.edu/en/tablecontents/sub\\_section\\_main\\_1120.aspx](http://ctb.ku.edu/en/tablecontents/sub_section_main_1120.aspx)
5. Paleontologist Jack Horner describes astonishing new findings about dinosaurs that drastically shift our understanding. Great story. – 18:23 minutes  
[http://www.ted.com/talks/jack\\_horner\\_shape\\_shifting\\_dinosaurs.html](http://www.ted.com/talks/jack_horner_shape_shifting_dinosaurs.html)

### Narrative

*When you ask questions, especially ones that people think they know the answers to, they might get annoyed. Asking questions like that can challenge people's expectations, both in*

*relation to social behavior and their own worlds. You might be asking questions that force them to re-examine the obvious, at least what seems obvious to them – or you might be asking them to consider something they don't like. Scientists such as Galileo, who supported Copernicus's view that the earth was not the center of the universe, paid a dear price for challenging the accepted thinking of his time. And when Lewis Thomas wrote "Fear of Pheromones" in 1974, he acknowledged that it might make people uncomfortable to think that human beings produce weird chemical signals similar to those that insects use:*

*What are we going to do if it turns out that we [humans] have pheromones [chemical substances secreted externally to convey information to others and produce specific responses on their part]? What on earth would we do with such things? With the richness of speech, and all our new devices for communication, why would we want to release odors into the air to convey information about anything? ... Why a gas, or droplets of moisture made to be deposited on fence posts?*

– Lewis Thomas, *The Lives of a Cell*

*But re-examining the obvious can be fun. Look what happens when a researcher in world health re-examines the assumptions of some of his students.*

### Video Resources

1. When Hans Rosling spoke at the US State Department in the summer of 2013, he used his fascinating data-bubble software to burst myths about the developing world, and reinforced the need to continue to question "facts."  
[http://www.ted.com/talks/hans\\_rosling\\_at\\_state.html](http://www.ted.com/talks/hans_rosling_at_state.html) Excerpt: 0:00 - 2:50 minutes
2. Paleontologist Jack Horner describes astonishing new findings about dinosaurs that



drastically shift our understanding. Great story. – 18:23 minutes

[http://www.ted.com/talks/jack\\_horner\\_shape\\_shifting\\_dinosaurs.html](http://www.ted.com/talks/jack_horner_shape_shifting_dinosaurs.html)

### *Class Discussion*

One of the most important parts of any project you will be doing in this class is to learn to ask a real question that interests you. We will talk about the scientific method, which aims to help you search for answers to your questions; but you need to have good, interesting questions to create interesting projects.

Asking questions is a developed habit. Throughout your school experience, you've probably felt like you weren't supposed to ask many questions. You are supposed to learn. And if you ask questions, they'd better be good ones. Well, we haven't begun talking about what makes a question good, but let's start with some exercises to help us get in the habit of asking questions.

*Accepted wisdom... is... often the opposite of critical thinking, which relies on questioning. In many schools, for example, critical thinkers are, if not punished, stifled because of their “disruptive” need to question (and thereby challenge authority).*

- From the Community Toolbox, contributed by Phil Rabinowitz

### *Class Exercise*

Ask students to complete the handout below with seven topics that interest them in the science class they are taking. What questions do they have about each? Where would they intuitively search for answers to those questions?

Handout: [Questioning and Scientific Inquiry](#)

Then collect the handouts and randomly give them out to other students (no names on this). Have the receiving student:

- Pick the two top questions of most interest to them and discuss if these questions include the one that the first student thought was most interesting.

- Identify what makes the two questions they chose interesting to them.

## Questioning And The Scientific Process = Fun And Surprises

Science should be fun – a creative exploration of the world around us that arises out of curiosity. However, it is sometimes difficult, given the standardized testing requirements and local school board mandates, to convey the joy of science. Focusing on questioning and ignorance may feel uncomfortable for some. But our goal is to try to turn inquiry into fun by allowing students to focus on things that interest them.

### Teacher Information

1. A compilation of brief answers from over 150 people, in different fields, about what makes them curious. Could use any samples of interest.

<http://curiosity.discovery.com/question/what-makes-you-curious>

2. How does it feel to realize you're wrong? Getting things wrong is fundamental to being human and is deeply related to our creativity. - 17.52 minutes

[http://www.ted.com/talks/kathryn\\_schulz\\_on\\_being\\_wrong.html](http://www.ted.com/talks/kathryn_schulz_on_being_wrong.html)

### Narrative

*What do you think makes for a “good question”? It's important that we try to figure that out. There's no right answer. But first, I want us to get used to simply asking questions. I want you to practice thinking, and thinking about things that make you wonder, just like Richard Feynman did. So before we*

talk more about the projects you'll be working on, let's talk about questions and their role in science, because the entire scientific process revolves around questions, as Lewis Thomas and Nobel Laureate Francois Jacob have written about it:

*...we have turned things around in science education. We confront students first with what we call the basics...a great mass of factual information. Only later...do we let them in on the secret that facts change...are biodegradable. We might be better off by letting the students know what the great puzzles are before they learn all the basic information-arouse their curiosity, make sure they get sufficiently puzzled about nature and then go on.*

- Lewis Thomas

*"The game was that of continually inventing a possible world, or a piece of a possible world, and then of comparing it with the real world.... a race without end... What mattered more than the answers were the questions... For me, this world of questions, and the provisional, this chase after an answer that was always put off to the next day, all that was euphoric. I lived in the future... I had turned my anxiety into my profession."*

— Nobelist Francois Jacob, *The Statue Within: An Autobiography*. Basic Books, New York, 1988.

You might enjoy watching a bit of this video, in which people from all walks of life talk about what makes them curious:

<http://curiosity.discovery.com/question/what-makes-you-curious>

At the beginning of any research project, your questions often revolve around, "What's my

research going to be?" That part of research is often called the "context of discovery." You're thinking, coming up with ideas, finding out which direction to go. The types of questions that researchers ask themselves, either explicitly or implicitly, are the same types we all ask ourselves when we encounter something we don't know or understand:

1. How does that work?
2. Why does that happen?
3. What if you take this and do that, what would happen?
4. What if I could create X to do Y?

So the context of discovery is simply a fancy name about wondering. Wondering how the world works and how life works.

Most other questions that arise during research are associated with what can be called the "context of validation." We will talk later about the scientific method, but examples of questions that arise during research include:

1. Is this an interesting question to test?
2. Can I create a test to answer my question?
3. Is this a good hypothesis?
4. Is this a good test of the hypothesis?
5. What if my test supports my hypothesis? What can I say or claim?
6. What if my test doesn't support my hypothesis? What can I say or claim?
7. What would I do with the knowledge I gain from the tests?
8. Would there be real-world application of such knowledge?

As obvious as this all might sound, the biggest stumbling block for all of us is getting used to asking questions, "uncorking them," whether they seem simple, complex, obvious, or unanswerable. Many of us don't want to appear dumb, so we don't ask what feels like a stupid question or one that we think other

people probably already know the answer to.

*But as we said before, answers are not always facts. They change all the time. Even without knowing much about Albert Einstein's general theory of relativity, you can probably appreciate that anyone who asked him the simple question, "What time is it?" would get an unexpected answer.*

### **Class Exercises**

1. Engage students in finding out why people are reluctant to ask questions and the type of questions they are reticent to ask.
2. Take the class for a brief walk – outdoors, down the hall, or wherever you can get them into an environment other than the classroom. Ask them to look at what they see and try to think of questions they have never asked themselves before.

## **Are There Answers And Does It Matter?**

Science is not a substitute for philosophy or religion. It is a method of learning more about the world we live in, and it is particularly suited to questions that have some possibility of being answered. And when answers are found and applied to real-world issues, they make a difference in people's lives.

### **Teacher Information**

1. Physicist David Deutsch discusses why the rise of scientific inquiry and understanding transformed the world within a few centuries.  
[http://www.ted.com/talks/david\\_deutsch\\_a\\_new\\_way\\_to\\_explain\\_explanation.html](http://www.ted.com/talks/david_deutsch_a_new_way_to_explain_explanation.html)
2. Surgeon Peter Attia argues that medicine's current approach to diabetes might be wrong because of the assumptions – and the judgmental attitudes – that underlie the approach.  
[http://www.ted.com/talks/peter\\_attia\\_what\\_if\\_we](http://www.ted.com/talks/peter_attia_what_if_we)

[\\_re\\_wrong\\_about\\_diabetes.html?utm\\_source=newsletter\\_daily&utm\\_campaign=daily&utm\\_medium=email&utm\\_content=image\\_\\_2013-06-25](http://www.ted.com/talks/peter_attia_what_if_we_re_wrong_about_diabetes.html?utm_source=newsletter_daily&utm_campaign=daily&utm_medium=email&utm_content=image__2013-06-25)

### **Narrative**

*In a while, we are going to talk about what makes for a good scientific question for research. But first, I want to talk about questions that are not really the domain of science-questions that cannot be answered using a scientific method or laboratory equipment. While these are not questions we'll pursue in this class, it's important for you to keep in mind the type of questions that are not answerable through the scientific method.*

### **| Video Resources**

1. Surgeon Peter Attia argues that medicine's current approach to diabetes might be wrong because of the assumptions - and the judgmental attitudes - that underlie the approach.15:58 minutes  
[http://www.ted.com/talks/peter\\_attia\\_what\\_if\\_we\\_re\\_wrong\\_about\\_diabetes.html?utm\\_source=newsletter\\_daily&utm\\_campaign=daily&utm\\_medium=email&utm\\_content=image\\_\\_2013-06-25](http://www.ted.com/talks/peter_attia_what_if_we_re_wrong_about_diabetes.html?utm_source=newsletter_daily&utm_campaign=daily&utm_medium=email&utm_content=image__2013-06-25)
2. Questions that no one knows the answers to. 12:08 minutes; suggested excerpt: 0:00 - 1:43 minutes  
[http://www.ted.com/talks/questions\\_no\\_one\\_knows\\_the\\_answers\\_to.html](http://www.ted.com/talks/questions_no_one_knows_the_answers_to.html)

### **Class Exercises**

Divide the class into groups of four. Have each group write up a list of questions and put the ones they think can be answered by science into a YES column – and those they think cannot be answered by science, into a NO column. Then have the class review what each group wrote and discuss why they agree or disagree with the way each question was categorized. Encourage students to interact with each other as they explain their thinking and possibly challenge each other.

## What Makes A Question “Good” Or Interesting?

No one metric can easily be used in all situations for the quality of questions. But one characteristic of good questions is that they engage the student and express a curiosity and desire to find out more – and when one question leads to another and to another. This makes it fertile ground for research. In this section, the goal is to encourage students to focus on questions that each person is interested in, rather than a rote assignment.

### Teacher Information

1. A guide to asking good questions. EssentialQuestions.pdf; suggested excerpt, page 1.  
<http://www.ocmboces.org/tfiles/folder1682/OHS>
2. Stephen Johnson discusses what kinds of environments foster unusual levels of creativity. – 17:46 minutes (suggested excerpt: 7:20-9:25)  
[http://www.ted.com/playlists/20/where\\_do\\_ideas\\_come\\_from.html?](http://www.ted.com/playlists/20/where_do_ideas_come_from.html?)
3. A brain surgeon observes, and asks herself some interesting questions, as her brain functions shut down one by one during a massive stroke. – 18:42 minutes  
[http://www.ted.com/talks/jill\\_bolte\\_taylor\\_s\\_powerful\\_stroke\\_of\\_insight.html](http://www.ted.com/talks/jill_bolte_taylor_s_powerful_stroke_of_insight.html)

### Narrative

*As you can imagine from Richard Feynman’s question about why the ball rolled to the back of the wagon when he began to pull it, as well as your own experiences, one good question is likely to lead to another...and another. Now we’re going to think about a question that interests you, and whether it would make a good research topic.*

*Go far, stay long, see deep.*  
– Outside Magazine

## *Class Exercises*

1. Ask students what they believe makes for a “good research question.”
2. Ask students to identify a topic they are interested in. If the class is conducive to a final project, this may well be the point to identify the research topic they will pursue.
3. Handout: [Questioning and My Interests](#)

After collecting the papers, mention that you will revisit this same exact exercise after your students begin their project. The point is to demonstrate that questions evolve and that the search for answers often leads to additional questions.

Excerpt From SIMI High School Student Sheridan Haskie (pg 19)

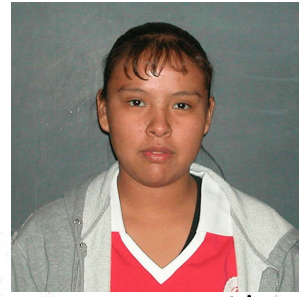
## Exercises In Questioning

The only way to become proficient at coming up with good questions is to practice. This section gives your students an opportunity to practice their questioning skills and discuss their thinking with each other.

### Teacher Information

1. Excerpt from My Cousin Vinny, in which he asks great questions - on Teacher Tube.  
[http://www.teachertube.com/viewVideo.php?title=My\\_Cousin\\_Vinny&video\\_id=119383](http://www.teachertube.com/viewVideo.php?title=My_Cousin_Vinny&video_id=119383)
2. A blog with clips from TV and movies that illustrate asking good questions.  
<http://larryferlazzo.edublogs.org/2012/08/04/the-best-videos-showing-the-importance-of-asking-good-questions-help-me-find-more/>





July 3, 2003

## A Good Question

By: Sheridan Haskie

There are questions everywhere. They come when you expect it or when you least expect it. You can't go anywhere without hearing or thinking about a question. A question matters, whether it's just a simple conversation or a complex deep presentation, the questions are there. With all the questions there are, Did you ever think what makes a good question?

A good question is brought to the matter by having a great subject to discuss it on. If there is a good subject to discuss the questioning can go on. We don't even have to be thinking about one subject to question. Some people just walk around or just look around as they do that they question things as they see them.

A good question would have to be thought provoking. A good question brings more questions to discussion. It don't have to have one answer but can have a few. If a question has one answer then that question might not be as interesting.

Although a good question is not just about the subject. You have to know how to put it together. Sometimes if you have a great question but sounds a little off then people wouldn't care. That is why it is important to put it together right. Some of the time the most simple question can put the most mind boggling thought into it. It also have to be able to be followed up by another question. A great question will be making someone think after the whole conversation is over.

Questioning is a very important way that we manage to survive this long. What would happen if we didn't have questions? Would the technology and architecture we have now be here, if we didn't have the chance to question it to make it better. What if you couldn't look at something and say that "It could be better?" Our lives revolves around questioning. Where would we be without it.

## Narrative

We've talked about what doesn't make for a good research question, which is one that simply can't be answered. And we've talked about what makes for a good question, which is something that is potentially answerable

and of interest to you. Without a personal interest, it is difficult to really become passionate about scientific research. But before you finalize your topic for a final project, let's do some exercises to see what kind of questions might come up if you chose a particular topic.

The collage features several educational components:

- The Questionator:** A software interface for creating and managing questions. It shows a poll titled "Ignorance is bad thing?" with results: 1. yes (84%), 2. no (16%), and 3. not sure (0%).
- Ignorance Log:** A table for tracking questions and progress.
 

WEEK 01	
Questions considered and how they relate?	What is ignorance? How do I know what the author says is true? Do we really know anything? Will I ever know enough to be truly ignorant? How do scientists think up the things they discover?
Activities and progress?	For colon cancer patient - Do I know enough to answer the questions? What do I need to do for my final report? How do approaches to ignorance in transplantation currently?
How ideas and approaches?	Can we believe what we read or what we've taught? Critical analysis of the literature - it's not always what it seems. Questions - it reveals new knowledge.
- Grow Your Own Organ:** A press release dated January 1, 2010, from UMC Surgeon Performed, titled "Grow Your Own Organ Implants".
- Ignorance Map:** A circular diagram with five segments:
  - Known Unknowns:** All the things you know you don't know.
  - Unknown Unknowns:** All the things you don't know you don't know.
  - Errors:** All the things you think you know but don't.
  - Taboos:** Dangerous, polluting, or forbidden knowledge.
  - Denials:** All the things too painful to know, so you don't.

**Figure 3: The Curriculum on Medical and Other Ignorance Activities**

Witte MH, A Kerwin, CL Witte: Seminars, clinics, and laboratories on medical ignorance. J. Med. Educ. 63:793-795, 1988.



## Class Exercises

Distribute one of the scenarios (press releases) used in SIMI (e.g., ‘Growing Your Own Organ’) in the Translation Theme section or create a “press release” of your own that is more appropriate to topics you teach, or have the student bring in recent news articles about medical breakthroughs/medical oddities.

What is your overall reaction to the scenario - positive or negative/good or bad? Ask at least 1 question in each of 3 categories about the scenario: Type 1: basic science (inner workings of body processes or mechanisms of disease), Type 2: clinical (about a patient or whole person); Type 3 (societal, ethical, legal issues)

## Student Project

As we said early on in this outline, constructing a final project that teaches others is, in our experience, one of the best ways to learn a topic. We therefore hope that this curriculum on questioning leads to a student project, whether it’s a science fair or a domain-specific project related to your class. Our focus throughout has been the portion of scientific method that stresses observation and creating good, researchable questions.

## Teacher Information

We hope that we have provided resources that were useful to you as you emphasize the importance of this first step in the scientific method. Information and resources for your students to create a final project are provided at the close of the second part of this curriculum: Translational Science and the Research Enterprise.

## Narrative

*By now, you know some things that you found interesting, and you are learning what makes for good questions. Maybe you’ve already asked some. So now comes your biggest*

*chance to turn one of those questions - or a different one - into a project that really interests you and that can translate to some issue we face in the real world.*

## Class Exercises

An outline of the project introduction we use might be useful to you.

1. **Project Preparation** – Ask students to track the path of their questions and be prepared to answer:

- What questions did you have at the beginning?
- What questions arose as you were researching the first questions?
- How do you go about looking for answers to the questions you currently have?
- What resources could you use to look for answers?

2. **Observation Exercise** – The goal here is not only for students to accurately describe their close observations about an object, photograph, experiment, but to ask several questions based on them.

3. **Background Review for Project** – Have your students identify seminal readings or websites in their area of interest. Their questions should include:

- What does the author think he knows? (i.e., identify the author’s assumptions)
- What is the author ignorant of?
- What is his/her basic question?
- What are you, the reader, ignorant of before reading the paper?
- What are you, the reader, ignorant of after reading the paper?
- What questions were raised by the paper?

4. **Focus** – What will the student’s project focus on, and what are the questions they start with?

*When the scientist tells you he does not know the answer, he is an ignorant man. When he tells you he has a hunch about how it will work, he is uncertain about it. When he is*

*pretty sure of how it is going to work, and he tells you, 'This is the way it's going to work, I'll bet,' he is still in some doubt. And it is of paramount importance, in order to make progress, that we recognize this ignorance and this doubt. Because we have the doubt, we then propose looking in new directions for new ideas. The rate of the development of science is not the rate at which you make observations alone but, much more important, the rate at which you create new things to test.*

– Richard Feynman, *The Meaning Of It All* (27)

## **SIMI Student Reflections On Questioning**

Quotes from SIMI High School Students:

*“This summer I ran upon many questions... questions that got answered, questions that got half-answered, and questions that didn’t get answered”.*

*“Before I began this program, I believed that asking questions was a form of stupidity. I was so nervous and afraid.”*

*“I never thought of myself as ignorant, but once I realized it, I began to think on a more*

*critical plane. I am a better analyzer, but I need to write down my questions more because I forget them.”*

*“Until this week, it never hit me how much I have begun to use questions in every part of my life... Questions keep filling and expanding in my brain like carbonation in a soda can after it has been vigorously shook. I found that the only way to impede the explosion of my brain was to write the questions down so they had somewhere else to exist... I never would have guessed that a simple set of daily worksheets would have impacted my life so much.”*

*“I am no longer self-conscious that the level of ignorance my questions hold will define my level of intelligence: they only define my ambition to learn.”*

*“This summer showed me I need to ask questions. I’ve learned that just sitting in the back of the room, taking in all the information, is not going to help me; I need to be in the middle of it all, amid all the action, interacting with the person speaking. We need to investigate things and find what’s real, what’s true.”*



# The Translational Theme

## WHAT IS TRANSLATION?

Translation has a variety of meanings and nuances:

“...the bidirectional process of applying ideas, insights, and discoveries generated through basic science inquiry to the treatment and prevention of human disease...” National Institutes of Health

Webster’s dictionary definition:

Translation: 1. Rendering of something into another language. 2. A version in a different language. 3. Change or conversion to another form, appearance, transformation. 4. Act or process of translating. 5. motion in which all particles of a body move with the same velocity along parallel paths. 6. Retransmitting or forwarding of a message, as by relay.

Biochemistry: “the synthesis of a polypeptide from its mRNA template”

What do the different meanings of translation have in common, how do they differ, and what are their implications for each other?

## *Translational Science And The Research Enterprise*

Many people are good scientists. They have asked good questions, they have stimulated others with interesting research, and their findings are exciting. But scientific research often gets stuck in the lab. Why? And how does basic research lead to real-world situations, like developing new drugs and understanding illness?

This is our topic in the second part of this curriculum. As translational researchers, we take the basic research we have conducted in our labs and translate it into applications that benefit people.

Doing this necessitates a paradigm shift in the way we conceive of the relationship between medical “knowledge” (the known), and medical “ignorance” (unanswered questions and unquestioned answers-the unknown) in the translational process. Today’s students are faced with mountains of knowledge from centuries of research, and they can link to it instantly. Yet, medicine and science are most

often furthered by those who question and thereby discover.

What has been missing is a program that amalgamates medical knowledge and student-centered inquiry. Through this curriculum, your students can now simultaneously acquire different kinds of knowledge through the interweaving of its two modules – this second one, with its medical/scientific and translational concept/content, and the ignorance/inquiry modules we began with.

## What Is Translational Research?

*“Translational research is scientific research that helps to make findings from basic science useful for practical applications that enhance human health and well-being. It is practiced in the medical, behavioral, and social sciences. For example, in medicine it is used to “translate” findings in basic research quickly into medical practice and meaningful health outcomes. Applying knowledge from*

*basic science is a major stumbling block in science, partially due to the compartmentalization within science. Hence, translational research is seen as a key component to finding practical applications, especially within medicine.”*

[\(Wikipedia\)](#)

*“Clinical and translational science are fields devoted to investigating human health and disease, interventions and outcomes for the purposes of developing new treatment approaches, devices, and modalities to improve health. New molecular tools and diagnostic technologies based on clinical and translational research have led to a better understanding of human disease and the applications of new therapeutics for enhanced health.”*

– D Robertson and G Williams, *Clinical and Translational Science: Principles of Human Research*, Copyright 2009 Elsevier Inc.

Translational research is also sometimes referred to as “bench to bedside.” In medicine, this is where basic science research and clinical medicine interface – such as the long research that translated the curious phenomenon of mold in a petri dish into the wonder drug that penicillin became, which forever changed medicine and has saved countless lives.

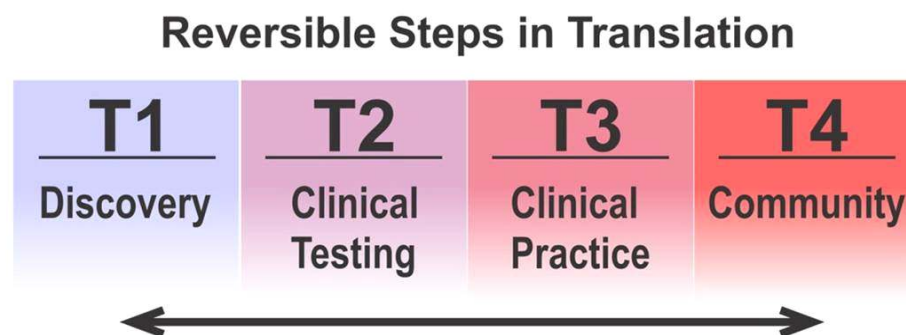
But translation often occurs in the reverse direction – “bedside to bench and back again,” such as the observation in patients with bacterial (pneumococcal) pneumonia that the “information” programming virulence of the smooth encapsulated form of the *Pneumococcus* was contained in a sugar molecule (DNA) and not a complex protein. This revolutionary bedside to bench discovery in 1944 of the “transforming principle” and that genes are made of DNA preceded elucidation of the double helix structure of DNA by nearly a decade and the beginning of its full bench to bedside applications in the Human Genome Project 50 years later.

McCarty, M: *The Transforming Principle: Discovering that genes are made of DNA*. 1985

Watson, J: *The Double Helix*. 1968. Atheneum

Other examples of Basic Science Implications of Clinical Observations, such as the dietary cure of pernicious anemia which led to the discovery of vitamin B12 (cobalamin) and its physiologic role, can be found in a series of occasional articles under this title in the New England Journal of Medicine.

H. Franklin Bunn, MD: Vitamin B12 and Pernicious Anemia - The Dawn of Molecular Medicine. *NEJM* 370: 773-776, 2014



**Figure 4. T1= Basic Scientific Discovery and Translation to Humans, T2=Translation to Patients, T3=Translation to Practice, T4=Translation to Populations.**

Translational biomedical research was originally divided into 2 categories: T1 research, the “bench-to-bedside” enterprise of translating knowledge from the basic sciences into the development of new medical treatments; and T2 research, translating the findings from clinical trials into everyday practice. This scheme has recently been expanded into 4 categories on a continuum (Fig. 4).

Here, we discuss translational research from this medical point of view, including the related political, financial, and public health issues involved.

### Teacher Information

1. “What Is Translational Research and Why Do You Think it is the Way to Achieve Better Clinical Results?” – Eric Rose, M.D., chairman of the Department of Surgery, Columbia University Medical Center, discusses translational research. [http://www.cumc.columbia.edu/publications/in-vivo/vol4\\_iss1\\_mar\\_apr\\_05/translation\\_research.html](http://www.cumc.columbia.edu/publications/in-vivo/vol4_iss1_mar_apr_05/translation_research.html)
2. “The Meaning of Translational Research and Why It Matters” – from the Journal of the American Medical Association <http://jama.jamanetwork.com/article.aspx?articleid=1149350>
3. A Historical Perspective on Clinical Research – from the ancients to the 20th century – is concisely presented in Principles and Practice in Clinical Research by John Gallin, Academic Press, 2002, pp 1-11.
4. Another historical and fascinating source is *Classical Descriptions of Disease* which represent the original descriptions by the physicians who recognized these disorders and their thinking about mechanisms, tools, and management as well as manifestations.

Ralph H. Major: Classic descriptions of disease; with biographical sketches of the authors, With 127 illus. Springfield, Ill., C. C. Thomas, 1932.

### Narrative

*Somewhere along the way, many of us have come across the idea that basic research is the source of true discovery – probing the very nature of the world, from particle physics to cosmology – whereas applied research is not “real” research. Instead, applied research is often considered to be similar to what engineers do: design things, make them, fix them (even this view of engineering is limited). But this distinction between basic and applied research can mistakenly be essentially a class perception of intellectual superiority.*

### Video Resources

1. A good overview of translation from an emotional/human perspective – a promotional video for The Altman Clinical and Translational Research Institute at the University of California at San Diego. – 5:58 minutes <http://www.youtube.com/watch?v=2EAJV9I4r7g>
2. Career Girls: Physician/Scientist “Translational Research” (part of the Career Girls ongoing series of career guidance/ inspiration videos.) – 1:38 minutes <http://www.youtube.com/watch?v=xcDLdMYb1jg> (See more at <http://www.careergirls.org>)
3. Basic and translational research are both important to the advancement of human knowledge, but they work in different ways and have different end goals. <http://www.wisegeek.com/what-is-the-difference-between-basic-and-applied-research.htm>
4. Article /advertisement on what translational research is, and the many occupations that are ways to engage in it. [http://www.labanswer.com/translational\\_research\\_laboratories.asp?gclid=CI\\_n4IXM0rkCFQie4AodkRIAQQ](http://www.labanswer.com/translational_research_laboratories.asp?gclid=CI_n4IXM0rkCFQie4AodkRIAQQ)

*[Nobel laureate] Sydney Brenner is one of many scientists challenging the idea that translational research is just about carrying results from bench to bedside, arguing that the importance of reversing that polarity has been overlooked. "I'm advocating it go the other way," Brenner said. Bedside to bench means that clinical trials and patients' unexpected responses are valuable human experiments, and failed trials can stimulate new hypotheses that may help refine the experiment in its next iteration.*

– From <http://www.nature.com/news/2008/080611/full/453843a.html>

### *Class Exercises*

1. Have students think of examples of medical treatments, or procedures such as the flu vaccine or x-ray visualization. Then have them trace their probable development from the lab and observations.
2. Ask them to pick a historical period that interests them and find out how science advanced our common humanity at the time. How did it probe and push the boundaries of what was possible then?
3. Explain some new technologies to students and then have them come up with applications for them. Also, have them trace how the technologies were discovered. A good example is polymerase chain reaction (PCR).

principle” and Vitamin B12 treatment of pernicious anemia.

“The Meaning of Translational Research: the Story of Penicillin”

[http://www.ox.ac.uk/research/medical\\_sciences/projects/penicillin.html](http://www.ox.ac.uk/research/medical_sciences/projects/penicillin.html)

<http://ctb.ku.edu/>

[http://ctb.ku.edu/en/tablecontents/sub\\_section\\_main\\_1120.aspx](http://ctb.ku.edu/en/tablecontents/sub_section_main_1120.aspx)

*You'd be hard pressed to find an advance in almost any area of humanity's development that didn't start with someone looking at the way things were and saying "It doesn't have to be that way. What if we looked at it from another angle?"*

– The Community Toolbox

### Examples Of Translational Research

How penicillin became the wonder drug it did, and transformed medicine is, as we mentioned, a shining example of translational research. It is also a wonderful example of the way that teamwork and collaboration produce results that would not otherwise occur. We will use it for some of the class exercises going forward in this part of the curriculum. Other examples mentioned above include discovery of DNA as the “transforming

### **Teacher Information**

1. Background information on encouraging students to formulate questions. See earlier section on questioning.

### **Resource**

2. Drug Discovery

## Narrative

*How penicillin evolved from Alexander Fleming's 1928 observation of mold growing in a petri dish to become a revolutionary drug that forever changed medicine and saved countless lives, is a wonderful example of translational research. Fleming, a biologist, pharmacologist, and botanist, noticed an empty spot in the center of a bacteria-cultured petri dish where something grew that was killing off the bacteria. He named it "penicillin" and continued to investigate it for about a year, but stopped because it was too difficult to grow and store.*

*Two other men, who realized that the odd substance had medicinal properties and were prompted by the widespread battlefield infections then being seen in World War II to continue their investigations, but they couldn't find a way to produce sufficient amounts of it to test it. However, a laboratory had begun to investigate penicillin on a small scale, and the two men eventually took over the lab and initiated penicillin's transition into the medical setting by experimenting with rats, and eventually with humans.*

*The watershed advance in medical science that penicillin came to represent, as the first laboratory-produced and controlled antibiotic, began as basic research - just as happens with other drugs and biomedical devices. And the story of penicillin illustrates both areas of translational research: (1) applying discoveries generated by laboratory research to preclinical studies and clinical studies in humans; and (2) translating the findings of clinical trials into everyday practice.*

*The bottom line is that penicillin only became the revolutionary drug it did because translational research made it happen. Otherwise, it would have stayed in the lab.*

## Video Resources

Bedside to bench – Nature recounts three stories in which results from human experiments inspired new avenues of research.  
<http://www.nature.com/news/2008/080611/full/453843a.html>

The emerging paradigm (with many historical examples) in biomedical research termed – “translational research” – focuses on iterative feedback loops between the basic and clinical research domains to accelerate knowledge translation from the bedside to the bench, and back again.  
[http://en.wikipedia.org/wiki/Medical\\_research](http://en.wikipedia.org/wiki/Medical_research)

## Class Exercises

1. Ask your students to think about people they know (including themselves) who have been treated with penicillin, and the varieties of medical issues for which they were treated. Did penicillin work? Did they need to change antibiotics? What was their experience like? Was it easy to take, or could it have been improved in some way? Did anything happen to anyone that might have been useful for researchers to know? Why do they think that so many other antibiotics have been developed since penicillin came into being?
2. Encourage your students to come up with similar examples in history or select current events “ripped from the headlines” and then have them list their Type 1, 2, and 3 basic, clinical and societal (ethical, legal, social) questions at the beginning of their research on the topic and at the conclusion. A follow-up exercise could be having the opportunity to interview an expert on the topic, pose their unanswered questions, and also elicit the unanswered questions on the topic from the expert. The student then might also explore with the expert how some of these questions could be answered and what research tools might be used.



## Science As A Social Activity

Unlike the popular view of scientific researchers working alone in their labs, scientific research involves teamwork. No one individual has all the expertise required for the full exploration of a project. So this segment stresses the importance of teamwork and collaboration in conducting research, and applies this concept to the kids in your class, and the work and projects they undertake.

*Translational research requires skills and resources not usually available in a single laboratory or clinical setting.*

[http://www.labanswer.com/translational\\_research\\_laboratories.asp?gclid=CL\\_n4IXM0rkCFQie4AodkRIA0Q](http://www.labanswer.com/translational_research_laboratories.asp?gclid=CL_n4IXM0rkCFQie4AodkRIA0Q)

### Teacher Information

1. Video on the importance of creating environments that foster innovation and good ideas. 17:46 minutes  
[http://www.ted.com/playlists/20/where\\_do\\_ideas\\_come\\_from.html](http://www.ted.com/playlists/20/where_do_ideas_come_from.html)
2. How teamwork produced penicillin  
[http://www.ox.ac.uk/research/medical\\_sciences/projects/penicillin.html](http://www.ox.ac.uk/research/medical_sciences/projects/penicillin.html)
3. Videos by the Industrial Research Institute on its tournaments and programs to promote innovative research and development  
<http://www.iriweb.org/>
4. A diagram of the work cycle and the interconnections between its elements  
[http://www.iftf.org/fileadmin/user\\_upload/images/More\\_Projects\\_Images/TH-FutureofWork.jpg](http://www.iftf.org/fileadmin/user_upload/images/More_Projects_Images/TH-FutureofWork.jpg)
5. Enhancing Collaborative Communication in Translational Climate Science  
<http://www.cals.uidaho.edu/toolbox/pres/ORourke2.pdf>

## Narrative

*When you think of a scientist, you probably think of somebody wearing a white lab coat and working alone in their lab, studying a specimen or pouring something into a test tube. At least, that's a common stereotype of what scientists look like and how they work. But the truth is that scientific research is a team activity. No one person has all the training and specialized skills needed to carry out a research project, so researchers with different areas of expertise are needed to work together on the same problem. As you saw, the development of penicillin was an example of this, and there are endless others that we know about, and don't yet know about. You might be surprised to find yourself interested in some particular aspect of such a group development process.*

*We like to think of exploring in science as a lonely, meditative business, and so it is in the first stages, but always, sooner or later, before the enterprise reaches completion, as we explore, we call to each other...*

– Lewis Thomas, *Lives of a Cell*

### Class Exercises

1. Divide the class into groups of five and ask them to pretend they are working together to find ways to improve penicillin, based on the experiences with it that emerged during their last exercise. What could make it better, from its capabilities to the way it is taken? Encourage your students to really play with this and have fun!
2. After the exercise, ask them what they liked about the exercise and what was difficult for them-if anything.
3. Have them watch at least the first two videos below and discuss their reactions/thoughts.

## Video Resources

1. The importance of creating environments that foster innovation and good ideas. 17:46 minutes  
[http://www.ted.com/playlists/20/where\\_do\\_ideas\\_come\\_from.html](http://www.ted.com/playlists/20/where_do_ideas_come_from.html)
2. Breakthrough to Cures Games for Change is a global organization for games that can make a real-world positive impact. 4:17 minutes  
<http://info.breakthroughstocures.org/>  
See more at:  
<http://info.breakthroughstocures.org/#sthash.DdliYcrs.dpuf>
3. Videos and information by the Industrial Research Institute on its tournaments and programs to promote innovative research and development  
<http://www.iriweb.org/>
4. A diagram of the work cycle and the interconnections between its elements  
[http://www.iftf.org/fileadmin/user\\_upload/images/More\\_Projects\\_Images/TH-FutureofWork.jpg](http://www.iftf.org/fileadmin/user_upload/images/More_Projects_Images/TH-FutureofWork.jpg)

## The Research Enterprise

Research is conducted in both academic and commercial spheres, and both require funds. We have discussed the academic sphere, and now we need to address the support systems and businesses that are essential to completing and implementing the translation process. That's where "the rubber meets the road," and there are many needs for people to work in these areas of development. For example, biomedical equipment and materials are needed, as is logistical support. Legal support is needed to ensure that federal guidelines for development, testing, and distribution are properly met; lab technicians are needed to test the new drugs; marketing and sales are needed to get them to the consumers who can benefit from them. Without all of these participants and more, the best lab research in the world will stay in the lab.

Also, some of your students might enjoy gaming. If they do, we encourage you to let them watch the videos below, which utilize gaming skills and engage the gaming community in unconventional thinking that can translate into biomedical advances and other solutions to world problems. These games take place from time to time, and your students can participate at no cost. It is a very exciting enterprise that involves interaction with a different kind of community. The best ideas generated will be made public afterward, so we also caution your students to notice their good ideas and think about how they want their ideas to go out into the world.

**The training takes longer, but those willing to invest extra time in getting to grips with both basic and clinical research can reap the benefits, not least in job satisfaction, says Karen Kreeger.**

<http://www.nature.com/naturejobs/science/articles/10.1038/nj6952-1090a>

## Teacher Information

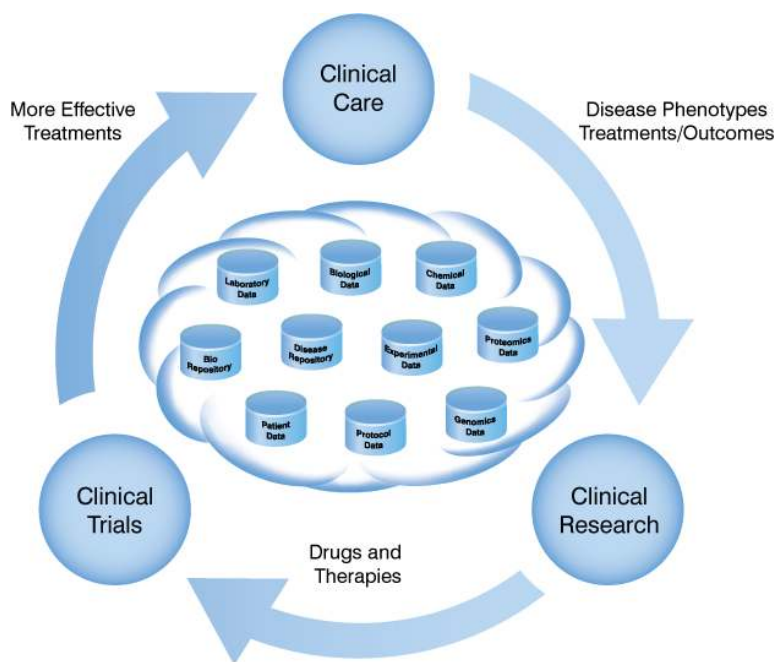
1. The changing role of pharmacists within the medical community - 18:27  
<http://www.youtube.com/watch?v=QnCGD05u58k&list=PLsRNoUx8w3rNv76zb5fXbng-dVNsN90BI>
2. A brief description of the difference between basic and applied research, and how the lines can blur.  
<http://www.wisegeek.com/what-is-the-difference-between-basic-and-applied-research.htm#didyouknowout>
3. TED Talk about how gamers and game playing can lead to solving some of the world's big problems. – 20:32 minutes; suggested sample: 5:00 minutes to end  
[http://info.breakthroughstocures.org/?page\\_id=7](http://info.breakthroughstocures.org/?page_id=7)
4. This article, from the Myelin Repair Foundation, relates to the gaming video above, and describes how gamers forecast the use of advanced data mining to accelerate medical research, among other things.  
<http://info.breakthroughstocures.org/wp-content/u>

## Narrative

*Do you ever wonder how researchers find or create new medicines, or figure out how they work? It's not only exciting for them – it can be life-changing for patients suffering from diseases and medical conditions. That's an extremely rewarding and powerful incentive for anyone who wants to make a difference in the lives of others, and the process of getting a new product from discovery through development, testing, approval, packaging, etc., involves many phases and provides many opportunities for involvement and for jobs, even if you are not a scientist.*

*For example, biomedical equipment and*

*materials are needed. Legal support is needed to ensure that federal guidelines for development, testing, and distribution are met; lab technicians are needed to test new drugs; marketing and salespeople are needed to get them to consumers who can benefit from them; pharmacists are needed to dispense them if they are not sold over the counter. Without all of these participants and more, the best lab research in the world will stay in the lab. So, as you move along in this class, see if this side of the translational process interests you, and if so, what part you particularly like. The diagram below shows the process that's involved in translating basic research into medical products that enter the marketplace and end up on the shelves of places like Walgreens, where they can help people.*



**Figure. 5.** Diagram excerpted from [http://www.labanswer.com/translational\\_research\\_laboratories.asp?gclid=CI\\_n4IXM0rkCFQie4AodkRlAOQ](http://www.labanswer.com/translational_research_laboratories.asp?gclid=CI_n4IXM0rkCFQie4AodkRlAOQ)

## Class Exercises

Ask the class to get into groups of six. This time, have them assume different roles – from

lab technicians to patent lawyers to pharmaceutical reps to marketing and salespeople – whatever they'd like to be – as they brainstorm ways to get penicillin to get to



the point where it can be mass-produced and introduced into today's marketplace, as if it were a brand-new drug. What would they need to do? How would they market it, etc.? Let them assume whatever role they prefer – even if two people want to play the same role, and even if someone wants to change their role in mid-stream – and imagine how they would engage in the process.

## | Video Resources

1. This article, from the Myelin Repair Foundation, relates to the video on gaming listed above, and describes how gamers forecast the use of advanced data mining to accelerate medical research (among other things).  
<http://info.breakthroughstocures.org/wp-content/uploads/2011/01/BTC-Final-Report-Release-01-31-2011.pdf>
2. Breakthrough to Cures Games for Change is a global organization for games that aims to make a positive impact on real-world problems. 4:17 minutes  
<http://info.breakthroughstocures.org/>  
See more at:  
<http://info.breakthroughstocures.org/#sthash.DdIiYcrs.dpuf>
3. Summary of the ideas that came out of the games conducted by Breakthrough to Cures - hosted by the Myelin Repair Foundation  
[http://info.breakthroughstocures.org/wp-content/uploads/2011/01/BreakthroughstoCures\\_GameSummary.pdf](http://info.breakthroughstocures.org/wp-content/uploads/2011/01/BreakthroughstoCures_GameSummary.pdf)

## How External Factors Can Affect Translation

### Teacher Information

External factors can profoundly re-order the priorities that an agency or a nation assigns to a field of inquiry, or to a particular type of research taking place within a field of inquiry. These factors include social, environmental, financial, and political events, as well as epidemics (such as HIV/AIDS, swine flu) and other extreme

health-related circumstances. Just as the incidence of battlefield infections during World War II pushed the creation of penicillin, external events can evoke a need for swift solutions and can prompt a heightened response and investment on the part of agencies such as governments, pharmaceutical companies, private-sector funding sources, etc., in the search for cures or preventive measures such as vaccines.

Conversely, a perceived absence of serious and immediate need can result in less interest and a more difficult time obtaining resources for research, even if the need is real. And, as the second resource below states, “political shifts, new legislation, new or modified regulations, global economic conditions, and changes in technology” can affect what gets researched – as can societal priorities in relation to human factors such as gender, ethnicity, race, age, socioeconomic status, etc.

1. How World War II affected the development of penicillin and other medical advances.  
[http://www.historylearningsite.co.uk/medicine\\_and\\_world\\_war\\_two.htm](http://www.historylearningsite.co.uk/medicine_and_world_war_two.htm)
2. This article is off-topic, but it clearly describes the external factors that affect research.  
<http://www.cdc.gov/niosh/nas/mining/pdfs/whatdoes-externalfactors.pdf>
3. “Transforming Clinical Research in the United States: Challenges and Opportunities: Workshop Summary” – from the National Center for Biotechnology Information  
<http://www.ncbi.nlm.nih.gov/books/NBK50888/>
4. Short article from European Cancer Organisation about external barriers to effective care in clinical research.  
[http://www.ecco-org.eu/Global/News/EBBC8-News/2012/03/23\\_03-NEWSLETTER-External-barriers-to-effective-care-in-clinical-research.aspx](http://www.ecco-org.eu/Global/News/EBBC8-News/2012/03/23_03-NEWSLETTER-External-barriers-to-effective-care-in-clinical-research.aspx)
5. Examination of challenges to the adoption of Internet-based technologies by healthcare organizations  
<http://www.ncbi.nlm.nih.gov/books/NBK44715/>

## Narrative

*When societies are faced with large-scale problems, the need for solutions becomes acute. At such times, resources tend to become available to enable researchers to solve the problem, and projects aimed at solutions are energized. Just as battlefield infections during WWII pushed the development of penicillin, nuclear energy and later nuclear accidents spawned a growing interest in understanding radiation-based illnesses and finding treatments and potential cures for them. Likewise, flu epidemics, the meteoric rise in the incidence of HIV/AIDS, and growing prevalence of heart disease have led to a pressing need for solutions, from vaccines and the development of new medications to hardware such as pacemakers and plastic valves.*

*In short, external factors often play a major role in determining what research projects receive attention and funding. And it works both ways: A perceived absence of serious and immediate need can result in less interest and a more difficult time obtaining resources for research, even if the need is real. In addition, political shifts, new legislation, new or modified regulations, global economic conditions, and changes in technology can affect what gets researched - as can societal priorities in relation to human factors such as gender, ethnicity, race, age, socioeconomic status, etc.*

*For example, if you belong to a group that is especially hard hit by some particular disease – or essentially “owns” that disease, as in the case of African Americans and sickle-cell anemia – and your group is not prioritized by the society you live in, you are much less likely to get the attention and the resources needed to find a solution to your medical issue. (One possibility might be to participate in devising a game that draws people to your cause).*

## Class Exercises

Have students discuss examples they know of where research or inquiry has been devoted to finding a cure for something – and cases where they saw a need but witnessed a lack of concern and public interest. Keep this as personal as possible.

### | Video Resources

A good overview of translation from an emotional/human perspective - a promotional video for The Altman Clinical and Translational Research Institute at the University of California at San Diego. – 5:58 minutes  
<http://www.youtube.com/watch?v=2EAJV9I4r7g>

## Student Project Resources

One vehicle for learning and communicating that learning which we have found particularly useful during the Summer Institute on Medical Ignorance (SIMI) is the assignment of a final project. All of these projects require an oral presentation in which the student describes their initial questions about the topic of their choice; an explanation of the research they conducted, based on those questions; and the questions the student discovered waiting for them as they pursued the questions they began with. Examples of student presentations can be viewed below.

In addition to the capstone presentation, all high-school and undergraduate students (medical students also participate in the summer institute) are required to produce a video that teaches others what they have learned about a research tool or technique. This exercise encourages students to work on their communication skills, so they are better prepared to share their findings and questions as they become engaged in scientific research or any aspect of the translational process. Some of the resources available to SIMI

students are listed below, and they might be helpful for you to use in appropriate settings.

### Student Resources

1. Video production assignment
2. <http://www.medicalignorance.org/progress/handouts/Video%20Project.pdf>
3. Creating an effective visual presentations
4. Capstone oral presentation handout
5. <http://www.youtube.com/watch?v=RQaW2bFieo8>

### Exercises In Translation:

#### Scenarios

Research topics can be found in news stories in the daily paper, on TV news, and online. These real world reports can serve as inspiration for asking questions, as well as questioning the veracity of the reporting, and of the research itself.

### Instructions

1. Take 5-7 minutes to read and study this press release and then list your questions.

2. Did you have a positive or negative reaction to the press release? (check one)

Q Positive

Q Negative

3. List one question you have about this press release in each of the following categories. (please put a check mark next to your best overall question):

BASIC BIOLOGY (underlying what was done and implications)

CLINICAL PRACTICE (diagnosis, management, treatment)

ETHICAL, LEGAL, MORAL ISSUES

### Scenario Topics

These scenarios have been created to be ‘almost believable’ but certainly will evoke questions and consideration.

### Grow Your Own Organ

#### PRESS RELEASE

#### **MEDICAL BREAKTHROUGH!: January 1, 2018 UMC Surgeon Performs 1st “Grow Your Own” Organ Implant**

A 3-month old baby girl dying from a rare metabolic liver disease received the gift of a new liver from her mother. Sources revealed that two months ago, a golf-ball sized portion of her mother’s liver was removed and subsequently “grown up” in tissue culture to a normal infant size in preparation for the historic operation. Last night, the infant’s failing liver was subtotally removed and the “made to order” new one implanted in its place. UA surgeons and basic scientists predict that this approach may be used to produce a whole variety of new “grow your own” organs eliminating the need for donors and harmful anti-rejection drugs. Anybody need an extra leg?

## Bird Flu

### **Bioterrorism Suspected in Arizona and Mexico, As Bird Flu Outbreak Threatens Lives, Profits**

TUCSON, Ariz., Nov. 15, 2017 – Arizona public health officials announced that 10,000 chickens will be slaughtered today in southern Arizona and northern Mexico to prevent the spread of bird flu.

But infectious disease experts and scientists from the U.S. Department of Homeland Security, puzzled about why this region has been hit so hard and where the virus came from, are investigating the possibility that the virulent flu outbreak is the result of a bioterrorist attack.

Four birds on a farm near the Arizona-Mexico border tested positive Monday for a strain of the H7 virus that state officials said, as far as they knew, did not transfer to humans. Various bird species in the Arivaca Cienega and Madera Canyon bird sanctuaries popular with birdwatchers are being tested.

Janelle D. Flyaway, director of the Arizona Department of Health Services, said the strain found in Arizona and Nogales, Sonora, Mexico, is different from a mutation of H5N1 avian virus. The A (H5N1) strain, which scientists believe is a mutation of a bird flu virus implicated in earlier Asian outbreaks, also caused the most recent epidemic in Asia, killing at least 18 people and necessitating the destruction of millions of chickens.

The human cases, with a few exceptions, were believed to have resulted from direct contact with infected chicken, said Flyaway.

To date, 28 human cases have been identified, with fatalities primarily in Vietnam. Other countries affected are Cambodia, China, Indonesia, Japan, Laos, South Korea and Thailand, according to the U.S. Centers for Disease Control. CDC scientists said no vaccine is available to protect humans against the deadly strain of avian

## Gene to cure baldness

### **Biotech Company Claims Breakthrough: New Gene Expression Technology Could Control Cancer, Cure Baldness**

NEW YORK, N.Y. April 5, 2018 - SUPERGENIX, a recently launched biotech company, went public today offering shares on the New York Stock Exchange, as it announced approval of its patents to cure male-pattern baldness and perform other marvels.

Myra T. Bushy, vice president for communications, said SUPERGENIX's breakthrough new technology will turn genes on and off.

"The prospects for enhancing athletic performance, growing hair, and evading airport security by promoting or silencing master genes and target genes, are truly mind-boggling, she said."

Bushy also noted that FDA approval is not required to market the new gene profiling and modification technology, based on extensive animal studies. The new methods will also enable scientists to alter pigmentation, changing hair and skin color, and to correct disease-causing mutations. In addition, the new therapies will be applicable to diseases such as cancer and congenital anomalies, where regulation of cell growth is a major problem.

### Federal Government to Subsidize New Obesity Drug

WASHINGTON, D.C., Jan. 2, 2017 – Dan D. Mann, secretary of health and human services, is urging the U.S. Food and Drug Administration to expedite the approval of a new obesity drug, Lipex, developed with funding from Merlox, Inc., the pharmaceutical giant. Mann promised that the federal government will subsidize all prescriptions of the drug in an effort to curb the growth of what he calls “one of the gravest public health threats to Americans today.”

In light of the recently announced standards for ideal weight and height, Lipex promises to bring the national rates of obesity down by as much as 50 percent in the next five years, saving tax payers up to \$39 billion a year-or about \$175 per person, according to a study by the Centers for Disease Control and Prevention.

Currently nine million children are obese, two out of every three adults are overweight or obese, and 300,000 die annually of obesity-related conditions, including Type 2 diabetes, cardiovascular disease, some cancers and gallbladder disease.

## Cancer Vaccine

### Potent Cancer Vaccine Ready for Clinical Trials

WASHINGTON, D.C., June 19, 2016 – The U.S. Food and Drug Administration has approved clinical trials for a potent new cancer vaccine, CVAX, that uses the patient’s own white cells to attack and destroy the malignancy. In high-risk patients, the vaccine is designed to prevent malignancies from forming in the first place.

Federal scientists, along with physicians and biomedical scientists at the in Boston and New York City, will begin the efficacy study immediately of 1,000 patients suffering from advanced stage breast cancer and melanoma.

An additional 50 patients will be included with a strong family history of breast cancer or melanoma who have not yet developed the disease.

The vaccine incorporates the patient’s own genetically altered cancer cells to help the body recognize them as cancerous; the body’s immune system, particularly the dendritic cells, can initiate the immune process.

A government spokesman, Hoff Rubocin, said the teams hope to have a vaccine ready for mass distribution within three years. If successful, said Rubocin, echoed by patient advocacy groups, “This could truly be THE cure for common cancers.”

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### Further Exercises

1. Return to the scenarios in the Questioning section. Now look at each from the perspective of translation and incorporate your basic, clinical and societal questions into the analysis. What basic science discoveries preceded the medical breakthrough? What sources will you use to find out? What

challenges faced the discoverers before they could apply the findings to the breakthrough? Also, students can select their own “medical breakthrough” from the current print media or internet and perform a similar analysis.

2. Have the students pick a common or rare medical disorder of interest to them and ask them to pursue the historical sequence of

research that led to understanding of the disorder. A valuable resource is Goodfellow, J, ed: Understanding Medical Research: The studies that shaped medicine. Wiley Blackwell, 2012. In this compendium, leading medical researchers in 8-13 pages each identify 10 primary research papers (quoted excerpts) that have “shaped the direction of research in their given topic, examining why they were carried out, key findings and how they changed the field, and ending with key outstanding questions, key research centers, and additional references. Topics covered range from heart failure, asthma, AIDS, and

stroke to epilepsy, migraine, inherited hemoglobin disorders, rheumatoid arthritis, and the biochemistry of depression.

To integrate with the Questioning Theme of the curriculum, they can begin with listing their starting questions and end with the questions that remain unanswered or new ones that have arisen during their readings or reflection. The final product could be a written report, oral presentation or even a video, which might be suitable for inclusion on the VCRC/Q alongside one by a medical expert on the same or related topic.

### **SIMI Student Reflections On Translation And Relation To Questioning**

*“My question process has become more streamlined. My basic science questions seem to bleed into my clinical questions which then seem to connect to the social questions.”*

*“SIMI taught me that asking questions is the only sure way to understand a subject. I have learned to think about questions from multiple lenses (basic science, clinical and ethical) and have thought about future topics to explore in my lab research from these three perspectives.”*

*“The initial questions I’ve had contained more basic biology type queries than all the other categories. However, after learning more about all of these basic processes, I feel like my questioning has shifted more to how this basic biology could be applied to real world situations and diagnoses.”*

*“I am starting to consider what about the topic is useful instead of what the topic is itself.”*

*“I began to ask more complicated questions and found more connections between the research I was doing which was more of a public health topic and the clinical implications and basic sciences.”*



# Overview of Evaluation

Keep in mind that the primary desired outcome and reward system of the TT/SQ Curriculum is students engaged in questioning and thinking about their thinking (more curious) as well as understanding the scientific process and translation. Students will not only be more science and health “literate” but many will choose medical/health science careers. Rewards should be structured according to these desired outcomes.

**W**e recommend using the logic model and formative assessment, both of which are defined below, as a means to assess the progress your students have made.

## The Logic Model (Fig. 6)

A logic model is a diagram that illustrates the rationale behind your program. It shows the relationships between the resources you invest (inputs), the activities you carry out (outputs), and the benefits you expect (outcomes).

You can read a logic model as a series of if/then statements that connect the different components of your program. For example:

If we have resources (inputs), we can carry out activities (outputs).  
(e.g., If we have funding for staff and appropriate materials, we can carry out after school EE programs.)

If we carry out activities (outputs), we create changes in participants (outcomes).  
(e.g., If we carry out after school EE programs, students’ environmental literacy will increase.)

(Adapted from W. K. Kellogg Foundation, 2004)

A logic model displays the sequence of actions that describe what a program is and

will do – how investments link to results. The five core components in a logic model are:

**INPUTS:** resources, contributions, investments that go into the course or program;

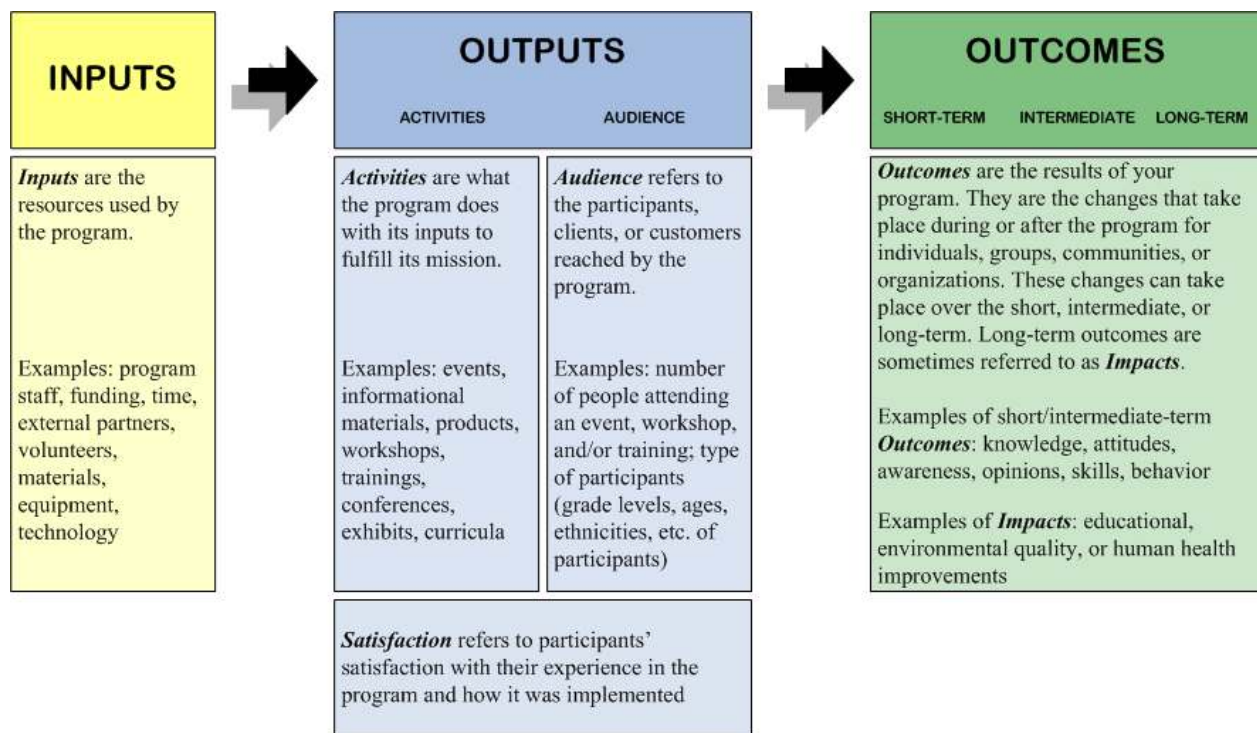
**OUTPUTS:** activities, services, events and products that reach people who participate or who are targeted;

**OUTCOMES:** results or changes for individuals, groups, communities, organizations, communities, or systems;

**ASSUMPTIONS:** the beliefs we have about the course or program, the people involved, and the context and the way we think the program will work;

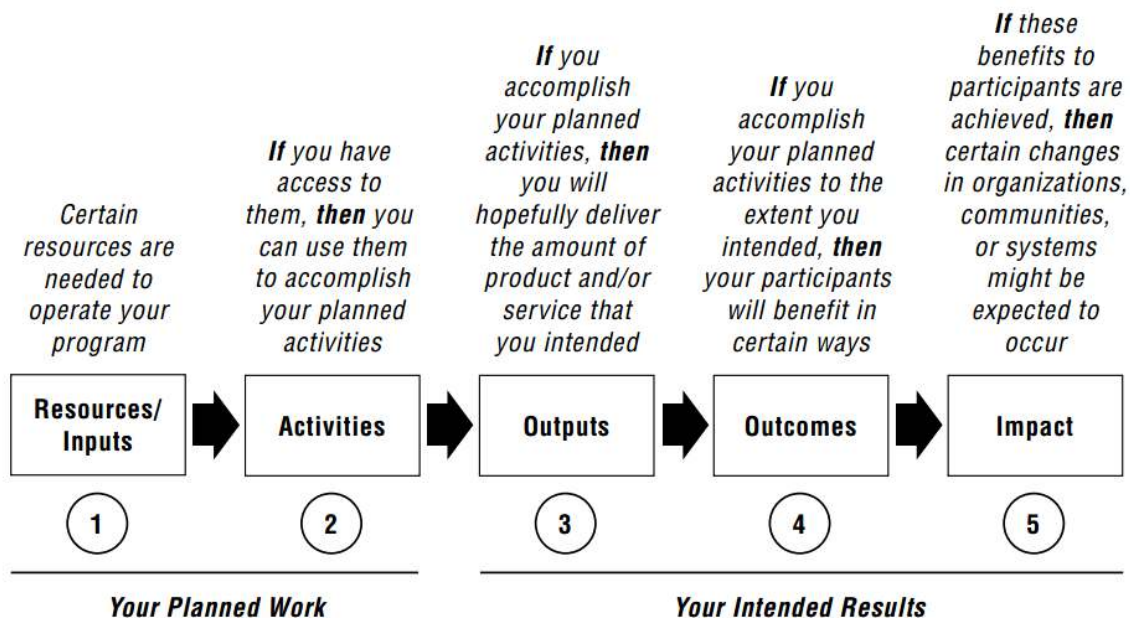
**EXTERNAL FACTORS:** the environment in which the program exists includes a variety of external factors that interact with and influence the program action.

The logic model is used in planning, implementation, evaluation and communication. While the term “program” is often used, a logic model is equally useful for describing group work, team work, community-based collaboratives and other complex organizational processes as we seek to promote results-based performance.”



**Figure 6. Logic Model Diagram.**

<http://meera.snre.umich.edu/plan-an-evaluation/step-2-clarify-program-logic>



<http://www.wkcf.org/resource-directory/resource/2006/02/wk-kellogg-foundation-logic-model-development-guide>



## Formative Assessment

Formative assessment is a process used by teachers and students during instruction that provides explicit feedback to adjust ongoing teaching and learning to improve students' achievement of intended instructional outcomes. Formative assessment is a method of continually evaluating students' academic needs and development within the classroom and precedes local benchmark assessments and state-mandated summative assessments.

Teachers who engage in formative assessments give continual, explicit feedback to students and assist them in answering the following questions:

1. Where am I going?
2. Where am I now?
3. How can I close the gap between the two?

In order to show students how to close the gap between where they are academically and where they want to be, teachers must help students evaluate their progress in the learning process and give them explicit, descriptive feedback specific to the learning task.

From: Heather Coffey, Learning NC, University of North Carolina at Chapel Hill School of Education, copyright ©2009.  
<http://www.learnnc.org/lp/pages/5212>

## SIMI and TT/SQ Curriculum Instruments Used (available for adaptation to your classroom)

- Pre-post Attitudes toward ignorance survey
- Pre-post Questions about 5 Medical Topics
- Comparison of Week 1 and Week 6 Ignorance Logs

- Final Course Evaluation
- Mentor Evaluation of Student Performance
- Portfolio of student products: Final oral presentation, Final written report, Research tool video, other
- Follow-up evaluation: Continuing education, career pathway, further research, honor and awards, leadership, presentations and publications, mentoring, community activities.
- Annual survey

## Toward An "IQ3" (Insights from SIMI):

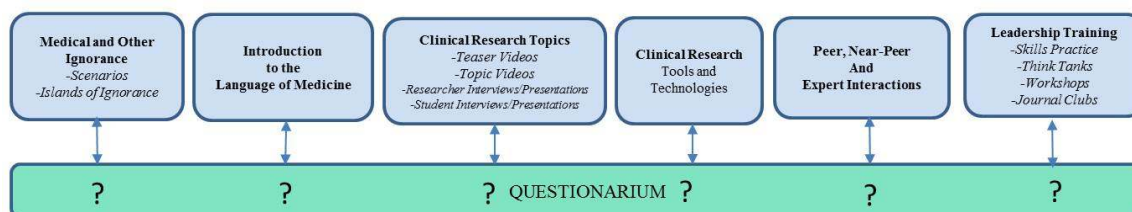
**Q3 scale (derived from student self-assessments)** – Pilot measure of student progress in questions, questioning, and as questioner - under study and validation:

**Questions: Dimensions** - breadth, depth, variety (multiple perspectives), content (what vs how/why), content (basic vs. applied), open/closed (tractability). Data sources: scenarios, question logs, self-assessment

**Questioning (Process)** - Dimensions: speed, volume (character counts), number of questions, connectivity/linkage vs. chaotic. Data source: Self-assessment, question logs, scenarios.

**Questioners: Dimensions** – Shyness/fear/embarrassment/discomfort vs. confidence/comfort; curiosity/joy/discovery; skeptical; value of questioning; humility; thoughtful. Data source: self-assessment, question logs, scenarios.

# TRANSLATING TRANSLATION AND SCIENTIFIC QUESTIONING CURRICULUM: PUTTING IT ALL TOGETHER WITH YOUR SIGNATURE



**Figure 7. Translating Translation Core Curriculum.**

A suggested sequence for the TT curriculum (Figs. 7) begins with the Questioning Theme and Introducing Medical Ignorance, evoking examples of each from the students followed by using some of the resources suggested or your own that parallel those presented. It is important to recruit the students to find their own examples from their personal life, family, or media sources. But most crucial of all, begin and continue, and end with some way to uncork student questions – handwritten, e-mailed, mobile phone access, so they remain continually active questioners. And have them frame their assignments with beginning and ending questions. Make sure to provide rewards and credit for the students questioning and progressing.

Then move on to the Medical Vocabulary Section which is a sequence on the Nature of Disease developed by UA Pathology Professors Ronald Weinstein and Anna Graham for high school level students. These have been adapted to the TT curriculum by including only 4 sessions on the Nature of Disease – Classification, Necrosis, Inflammation, and Neoplasia.

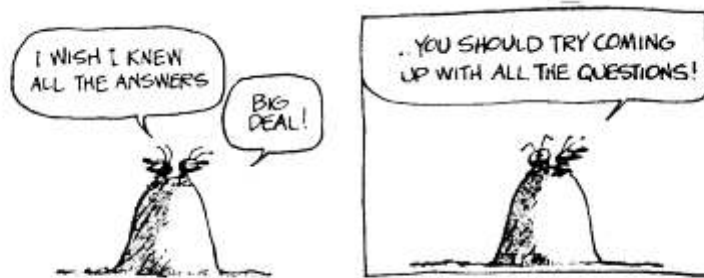
With this basic medical vocabulary now familiar, students can then expand their exploration of medical ignorance and take on

the subject of translation – continuing to frame their exploration with beginning and ending questions – basic, clinical and societal (paralleling the translational process). A “brain on-hands” on biomedical research experience would be optimal, if only for a brief few weeks or even a site visit or an adventure on the VCRC/Q with one of the featured researchers – a professional or a SIMI student – can then be the springboard for more questioning and a deepening understanding of the translational process. This is further reinforced by the scenarios, historical vignettes, variety of videos, and readings that illustrate the translational process – the promise and challenges – in medicine. Iterative questioning is the vehicle and exploration in the Questionarium is the continuing process that is designed to be engaging and curiosity-provoking for the students, luring them into science’s mysteries.

The TT/SQ Curriculum can be delivered in a “high octane” form, “low octane,” or “self-serve,” remembering that launching the students into their questioning journey – “uncorking” their questions/curiosity – is the crucial strategy – the sine qua non – for “engagement” and capturing the thrill and wonder of real science.

# EPILOGUE

*B*on voyage in your exploration of the worlds of Ignorance, Questioning, and Translation and keep in touch...



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