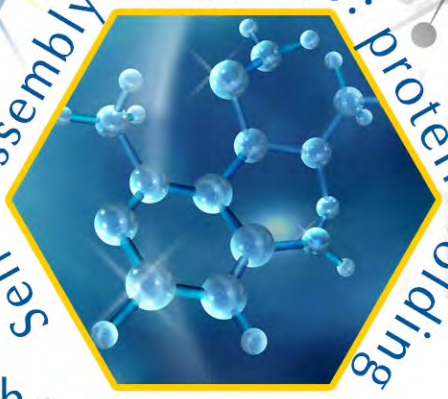
International Big History Association

Self - assembly in nature.. protein folding



A characterization of the IBHA

Enlarging the Scope of History

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Members' Newsletter

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Big History

Self-assembly in nature: protein folding

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There are several ways to observe the relationship between structure and complexity in the light of big history. One way could be to find the common factor between seemingly different entities. For instance, what do we have in common with cows, bees, apple trees, tomatoes and bacteria? The answer: we are all made up from molecules. All forms of life are made from the same basic building blocks. Therefore, understanding life lies in the knowledge about our building blocks, the molecules. Interactions of molecules lead to structures of increasing complexity, and ultimately to living organisms and their interactions. Since life is made from molecules, understanding these molecules will lead to a better understanding of life.

Firstly, let's talk about the level of which we discuss life, taking a human being as an example. Our bodies contain different organs and tissue, which in turn are made from even smaller units: cells. We define cells as the smallest unit of life. To illustrate, bones are cells, as well as muscle tissue or our brain. These cells are made from molecules. So, to summarize: organisms consist of cells, cells consist of molecules. This is true for all organisms. In this article I will focus on the level of molecules.

There are several important classes of molecules in our cells, such as DNA and proteins. Proteins carry out many of the crucial functions in our bodies. For instance, proteins transport hormones and nutrients. They can also be a structural part of our bones, or eyes. Many brain processes are also carried out by proteins. Proteins are a special class of molecules. They are rather large, and have a distinct and complex 3D structure. The structure of the protein is crucial to the function, meaning that a protein with the wrong structure will not be able to carry out its normal function. Therefore, the structure of the protein is tightly regulated inside the cells. I will give examples of protein malfunctioning later in the article.

To illustrate the importance of structure, I would like you to think of the following example. Imagine what happens when you boil an egg. In the beginning, the egg will be liquid, but after boiling it for a few minutes the egg is solid, as I am sure you all know. This process, from the liquid egg transforming into a solid egg, is irreversible. So what has happened inside the egg? Proteins are key here. In the egg at room temperature, the proteins inside are in their normal, correct structure. However, during the boiling process, the proteins inside the egg have slowly lost their structure and have unfolded. These unfolded proteins, which can be imagined as linear strands, have clustered together in what is called aggregates. These aggregates have led to the solid egg structure. The take-home message from this experiment: when proteins lose their structure, they can no longer carry out their functions but form aggregates instead. These aggregates completely change the physiology of the environment they are in.

At this point, let's discuss how proteins are made inside the cell. Each cell contains DNA, a molecule which stores all our genetic information and is unique in every organism and person. The DNA encodes the information for which proteins need to be made

inside the cell. This brings us to the central dogma of biology: DNA, which encodes all information, serves as a template for RNA formation. From RNA, proteins are synthesized. Proteins are synthesized as a linear strand: they have no structure, but can be imagined as a stretch of thread. Somehow, this thread folds into a ball of wool with a specific conformation. The exact mechanism how this happens is poorly understood.

Illustrated by the boiling egg example, we see what happens when many proteins unfold: they stick together and form aggregates, completely changing the structure of the entire egg. On the other hand, as I explained, proteins inside the cell are synthesized as linear strands. So, how are these new proteins prevented from aggregating together, and having the same fate as the boiling egg? One could only imagine what would happen to our cells if all proteins aggregated instead, turning the cells from liquid into solid structures. This would have disastrous consequences for the life of the cell.

This is when chaperone proteins enter the picture. Chaperones are a special class of proteins which assist newly synthesized linear proteins to fold into their specific, 3D structure. They prevent the new proteins, their clients, from aggregation. How they do this, exactly, is – again – unknown. In my research, I have focused on a specific chaperone: Hsp90. Hsp90 is highly conserved, from bacteria to man, and is crucial to many organisms, including humans. In this context, conserved means that the Hsp90 protein structure looks very similar in each organism, where it also has the same function. Hsp90 is very abundant: roughly 1% of all proteins inside the cell are Hsp90. Even though Hsp90 is present everywhere, it only helps about 200 other protein species fold. For the record, the human body has up to 100,000 different proteins present. Why Hsp90 has such a high selectivity for these 200 client proteins, is – you guessed it – a mystery.

One of these 200 proteins is the Tau protein. Hsp90-Tau interaction is one of the best characterized model systems for Hsp90, so we took this as a starting point in our research. Tau is a small protein of which we do not exactly know the function, but Tau is prevented from aggregation by binding to Hsp90. If this does not happen, unbound Tau will accumulate and aggregate, forming so-called “plaques” which are found in brain cells of Alzheimer’s patients. Tau is generally involved in neurodegenerative diseases, including Alzheimer’s. To aim for more knowledge of the Hsp90-Tau interaction, we set out to determine the mechanism of the binding. Note the top-down approach we applied here: we have a big question (how do proteins fold?), which we broke down in a smaller part by focusing on Hsp90 (how does Hsp90 help correct protein folding?) and dividing that into a smaller part even further (how does Hsp90 interact with protein Tau?). Let’s not forget, in the end we are interested in the fundamental issue of protein folding, but in the field of biochemistry and cell biology it is often necessary to break down large systems into smaller subunits to be able to understand them.

In my research internship, as mentioned, I investigated the nature of the binding between protein Tau with chaperone protein Hsp90. Our goal in the end is to elucidate the mechanisms by which proteins get assisted by Hsp90 to fold into their 3D structures, so they can do their functions. Of course many more experiments still need to be performed before protein folding is completely understood.

For now, I would like to focus your attention on some applications and consequences of protein folding, and the result of protein malfunctioning. In fact, many of our diseases are caused by malfunctioning proteins. These include Alzheimer’s disease, as mentioned before, Parkinson’s disease, sickle cell anemia, cancer, cystic fibrosis and many more. Thus, fundamental knowledge on protein folding will lead to better understanding of diseases, which in turn could lead to improved pharmaceuticals for curing, or even preventing some of these diseases.

In the first example of protein folding I would like to highlight cystic fibrosis. Cystic fibrosis is one of the most abundant genetic diseases in the western world. It affects mostly the lungs, in which a thick layer of mucus is formed. The prognosis of these patients is around 40 years. So, what causes this disease?

It turns out, one mutation (change) in the DNA of the patients leads to a protein with a mutation, with the consequence that the protein has a completely different structure compared to the protein structure in healthy patients (remember: central dogma of biology tells us DNA makes protein, so a change in DNA means a change in the corresponding protein). There is much research going on in the field of cystic fibrosis to cure this disease. What already is known is that the mutated protein in diseased patients lacks the ability to fold properly, thus is not able to fully carry out its function. Researchers are focusing on finding other proteins or pharmaceuticals to help this mutated protein fold in the correct structure, which is work still in progress. This illustrates the effects a single misfolded protein can have on the entire human body.

The second example is about improving proteins. People who suffer from diabetes, which is becoming an increasing problem, are dependent on the intake of insulin. Insulin is a protein, and since the protein structure is very important to the function, it is therefore necessary to keep the insulin in its 3D structure before injecting. For this reason, insulin is often kept in the fridge. Why is that? Think of the egg! Adding heat to proteins changes their structure, so it is best to keep a protein like insulin in the fridge. However, not everyone has access to refrigerators, especially after unexpected nature disasters in which inhabitants need to suddenly evacuate. Hence it would be nice to have an insulin protein which is somehow more stable than normal insulin, so it can be kept at higher temperatures without the fear of the protein losing its structure and corresponding function. However, the "improved" insulin must still have the same function, or else it will be useless to diabetes patients. Therefore, the protein structure of insulin should be investigated to understand what part of the structure is responsible for the function, and what part could be further stabilized to allow storage at higher temperatures. Fundamental understanding of the insulin folding and unfolding could be applied to improving insulin for storage at higher temperatures.

In conclusion, I hope I have been able to show you how fundamental protein knowledge not only influences related fields such as medicine and chemistry, but that it also teaches us more about life in general. Every organism on earth makes proteins made from the same building blocks, which are often very similar to proteins in different forms of life. The more we learn about protein folding in cells, the more we understand about life on earth.

Rebecca de Leeuw is a graduate student at Utrecht University, the Netherlands. She has completed a year-long internship in the field of cellular protein chemistry at the Bijvoet Center, part of the university. Her interests are chemistry in the context of cell biology. Her dream is to understand how molecules together lead to a living organism! She also likes how this type of research is interdisciplinary and links with many fields, including Big History, as she shows above. She believes that fundamental knowledge of molecules in nature leads to a better understanding of the world, because all organisms share the same building blocks. Rebecca has completed her Bachelor's degree in Molecular Life Science at the University of Amsterdam and will continue studying protein science with her next project at the University of Cambridge.

Evolution of pteropods:
planktonic gastropods in the world's oceans

Alice Burridge
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Last June I participated in the Big History symposium in Amsterdam, after being introduced to Big History earlier in 2013. Since September 2012 I hold a PhD-position at Naturalis Biodiversity Center in Leiden, The Netherlands, as well as a guest-status at the University of Amsterdam (UvA). I study evolution of planktonic gastropods in the world's oceans. Previously I have obtained a BSc degree in Physical Geography with a minor in Biology, and an MSc in Limnology and Oceanography (both at the UvA). During my final MSc project I lived in Oslo, Norway for seven months to study polar and subpolar radiolarians (another component of the plankton).

Planktonic organisms are highly diverse and inhabit oceans, lakes and ponds. Their sizes can vary enormously from femtoplankton (marine viruses, <0.2 µm) to megaplankton (>20 mm). The only prerequisite for being considered plankton is the inability to withstand currents. Many planktonic organisms are able to swim freely, but none can swim against the currents. Plankton can either be holoplankton or meroplankton. Holoplanktonic organisms spend their entire life cycle as plankton. Meroplanktonic organisms are only planktonic for part of their lives, usually the larval stage, and then become nektic (able to swim against the currents), or benthic (associated with the sea floor). The abundance and distribution of plankton strongly depend on nutrient concentrations and the abundance of other plankton. Zooplankton is the animal part of plankton. Other components of plankton are phytoplankton and bacterioplankton. Phytoplankton consists of photosynthesizing algae, whereas bacterioplankton plays an important role in re-mineralizing organic material in the water column.

Zooplankton is represented by as many as 14 animal phyla. Of special interest are pteropods. They are gastropods with two wing-like lobes of soft tissue (parapodia) that enable them to swim mainly vertically through the water column. Because of this, they are often called 'sea butterflies'. Their sizes range from 0.1 cm mesoplankton to 1.2 cm macroplankton. Pteropods can be divided in two clades: thecosomes (shelled), and gymnosomes (no shells). Unlike shelled land snails, not all thecosomes have coiled shells: for example, one genus has bottle-shaped shells; another has simple tip-shaped shells.

Thecosomes, or shelled pteropods, are special. They are the only zooplankton group with a fossil record. They originated *c*. 55 million years ago. Their shells consist of aragonite, a calcium carbonate mineral. It dissolves more easily under acidic conditions than the more stable calcite. This unfortunately means that shelled pteropods are highly vulnerable to ocean acidification, caused by an increased uptake of CO_2 by the oceans as the CO_2 concentration in the atmosphere increases. Therefore they are critical indicators of ocean acidification. Only some other phytoplankton groups have a fossil record, such as the calcifying coccolithophores and the siliceous diatoms and radiolarians, the latter group also being of special interest to me. All plankton groups with abundant fossil records enable a high-resolution reconstruction of their evolutionary histories. And all their little big histories together may sketch a more detailed picture of the history of life in the oceans. So, shelled pteropods are interesting. But where to begin?

To study the evolutionary history of thecosomes, first I should know more about the total present genetic and morphological diversity and complexity. Three DNA fragments have been selected to draw a tree of life for extant thecosomes, a phylogeny. Not all DNA fragments evolve at the same rate, and care should be taken for the selection of outgroups (sister groups, closely related non-thecosomes) to calibrate the group as a whole. Because thecosomes have a fossil record, I can calibrate the phylogeny at certain

points, indicating the ages of the supposed most recent common ancestors of thecosomes, a certain genus, or certain genera, as found in the fossil record. Using these calibration points, I can estimate the ages of other uncalibrated parts of the phylogeny, and the different rates of evolution within the phylogeny. A phylogeny is a model, a hypothesis, an approach of reality. Because I do not have the complete set of genetic information available (the genome, or rather, the transcriptome, only the expressed genes), some uncertainty remains. However, even once I have the whole transcriptome available, there still would be: not all genes evolve at the same speed. Thus, keep in mind that a phylogeny is an approach of a most likely evolutionary history.

Once I have a broad tree of life for all thecosomes, I can zoom in to find the little big histories within. I can zoom in to genus-level studies, or improve our phylogenetic framework of thecosome evolution by adding more genetic information. I am currently studying the quantitative morphological as well as genetic diversity in two genera. In this way I can determine finer patterns of evolution. Both genera under study occur in tropical and subtropical waters of the Indian, Pacific and Atlantic oceans. Continental masses between the oceans have caused genetic and morphological variation between the three major oceans. For example, the ancient Tethys Sea (now the Mediterranean Sea) once connected the Atlantic and Indian oceans, but closed *c*. 20 million years ago, resulting in a clear separation between Atlantic and Indian Ocean specimens. A broadly held view has been that evolution in the seas is, just like evolution on the land, mainly driven by these physical barriers to dispersal (spreading). However, this is not the entire picture. It has often been assumed that water masses are very homogeneous in all their properties. This is not true. 'Soft' environmental barriers (currents, temperatures, salinities, primary production, et cetera) are very important for getting a complete picture of evolution in the oceans. For example, there are two subtropical gyres in the Atlantic Ocean, separated by equatorial currents. Because I have found genetic and morphological variation in the northern, middle and southern Atlantic Ocean, I can link locations of certain morphotypes to ecological conditions and model the ecological preference of different morphotypes (ENM, Ecological Niche Modeling). This reveals that soft environmental barriers are as important to open-ocean evolution as physical barriers. Maybe even more important: soft barriers increase the speed of evolution (speciation) because of the pressure to adapt to an available ecological niche and/or the competition to find a suitable ecological niche within a major ocean.

Next, I can look at how selection is taking place and how it is influenced. Which parts of the transcriptome (all expressed genes) are under selection, which parts are likely not? How is calcification affected by future scenarios of ocean acidification? The whole transcriptome should be sequenced to answer this. Then I need to find (blast search) if specific fragments are associated with a certain functionality, such as calcification. Once I have found which part of the transcriptome is associated with calcification, I can focus on this region and examine if selection is taking place, visible as genetic structuring between different populations (in different ecological niches). I can then link this genetic basis to some more experimental morphological (phenotypic) studies on calcification effects that have already been published (i.e. lab culturing, direct shell measurements).

There is much more to be discovered in the oceans than you might think, and every next study raises new questions. I wonder if we ever get to know the entire big history of life in the oceans.

Alice Burridge

A Characterization of IBHA

By Cynthia Stokes Brown
IBHA Founding Board Member

{I wrote the description below of IBHA as an organization following lengthy discussions with IBHA member, Jennifer Morgan. Jennifer is working on setting up a website for networking the various groups who are engaged in telling and teaching some version of the Big Bang-to-present story. When we hypothesized whether or not IBHA might join the website as an organization, Jennifer volunteered to write its description. I responded, "Oh, let me see what I might write if I were trying to characterize IBHA." This is what I wrote, with some helpful edits by Fred Spier and Lowell Gustafson. I hope this short characterization may provoke discussion and enlarge consensus within IBHA about what kind of organization it is. In the next newsletter, Jennifer Morgan will describe further the website which will launch in early 2014.}

The International Big History Association (IBHA) is an academic organization encompassing all academic disciplines. Seven university professors from various disciplines founded IBHA in August 2010 in Coldigioco, Italy: Walter Alvarez (geology), Craig Benjamin (history), Cynthia Brown (education and history), David Christian (history), Lowell Gustafson (political science), Barry Rodrigue (anthropology, biology, history), and Fred Spier (biochemistry and anthropology). IBHA's current headquarters are at Grand Valley State University in Grand Rapids, MI.

The home page of IBHA opens with the statement that "Big History seeks to understand the integrated history of the Cosmos, Earth, Life, and Humanity, using the best available empirical evidence and scholarly methods." (See website www.ibhanet.org.)

The purpose of IBHA is twofold: it "exists to promote the unified and interdisciplinary study and teaching of the history of Cosmos, Earth, Life, and Humanity." In practice this means 1) research (keeping up with research in all fields, conducting research, and re-formulating the story as it continues to unfold, and 2) teaching (reforming education globally by teaching Big History K-graduate studies).

The methodology of Big History is firmly based on scientific methods---empirical evidence and the best scholarly methods. Big History seeks to present the current mainstream scientific consensus, while pointing out issues of contention and gaps in current knowledge.

The Big History story synthesizes the findings of the sciences and the humanities within a chronological timeframe. Mainstream Big History focuses on the emergence of increasing complexity, although some scholars and teachers prefer to avoid the term and tell the story in less analytical ways. More complex things consist of many, often diverse, components arranged in more-or less precise ways, held together by flows of energy under sufficient (Goldilocks) conditions, so that they in turn generate new emergent properties. The points in the story at which something new emerges some Big Historians call "thresholds." They often tell the story structured by eight succeeding thresholds of new complexity. Others use the terms "regimes" or "epochs" to designate the different phases in the story. Big history includes many forms of telling and responding to the story, such as poetry, art, music and literature.

The stance of IBHA is academic, global/international, and future-oriented. The study of Big History appears to indicate that humans are at a new threshold in the big story. The fossil fuel energy that put us into the modern period is changing our planet's atmosphere. Human activity is in fact changing the whole biosphere. Life as it is cannot remain stable. Will complexity continue to increase, or will it change and perhaps decrease? What ethical choices will humans make? How will those choices influence how the next threshold develops? Big historians believe that understanding the comprehensive map of where we are helps everyone understand better the choices before us.

Cycling to Knowledge with Big History

by Joya van Hout,
Attorney at Law, Founder and board member of "The Study Road Foundation"

Summary
This year we finished the pilot of *The Study Road* and cycled 12,500 km all the way from Istanbul to Beijing, visiting 8 universities where the pilot team took classes together with local students. It was an adventure in every way. And this was only the beginning. In this modest contribution I explain the concept and the values of *The Study Road*; its sources of inspiration; and how it integrates Big History in itscurriculum.

I. Introduction

Life is about learning, and the world is one gigantic classroom. That is my personal opinion, of course. School does not and cannot teach everything, and often the real learning starts only after graduation. And then all these developments on for example the Internet together with globalization emphasize this fact only more. Today everything is possible, but to some this can be suffocating as well. The options, the possibilities, the choices that need to be made are immense. We think it is more and more important to find ways how to guide yourself through life towards your own set goals. Getting yourself a compass and learn how to use it is rather handy. And this is what we wish to offer our participants.

II. The Study Road – study on your bike

The Study Road challenges the status quo of education. We think that education could be more fun, adventurous and challenging. We do this through a cross-continental expedition on a bicycle combined with a study program centered around Big History at universities en route. The first edition of The Study Road is the Silk Road. In a period of 5.5 months the participants cycle 12,500 kilometer from Istanbul to Beijing. In the main cities they take lectures together with local students facilitated by universities, companies and NGO's. Next to the focus on Big History we provide training in leadership skills, personal development and some aspects of group dynamics. Theory and practice go hand in hand. Big History will be the foundation on which the lectures at the universities will elaborate. In the final part of this article more is explained about Big History during *The Study Road*.

The core values of *The Study Road Foundation* can be summarized in three principles, active learning, creating a platform and promotion of cycling. We think active learning is a good way to learn through experience. A (online) network or platform of cyclists, students, universities and companies should encourage cross-learning, interaction and should provide all the benefits that other networks provide as well. Finally we promote cycling through collaboration with other initiatives and provide advice to universities who seek ways to promote cycling at their campus. Cycling is a fun, cheap and green way of transportation and also a good way to stay in shape. For *The Study Road*, cycling is the way to bring people of various backgrounds together in a shared

mission. But why is *The Study Road* different from a cycling-holiday or a study abroad program? I would like to explain to you why I started *The Study Road* two years ago and what the believes of our current team are.

III. Inspiration

I started with *The Study Road* after cycling 12,000 km through Africa with 55 people from all over the world. After returning home to The Netherlands I got the idea to combine a cycling expedition with a study program. During my studies in International and European law I studied abroad several times. Imagine these two together, I thought, this would form an ultimate learning experience that could teach participants about themselves and the world around them. Let me explain why.

Cycling from Cairo to Cape Town
Before my participation in this 12,500 km cycling trip I never cycled long stretches at a time. I was barely prepared when I started in Cape Town and I was convinced that my basic condition and my strong determination would get me through. The first week in the cycling trip was horrible. I got a huge pain in my knee because I was paddling with too much resistance. I got sick in Ethiopia and I learned that my will was too strong for my body. I learned to listen to both and to balance in between. Cycling through countries I only heard of from the news or from my fellow student buddies in South Africa and France where a lot of Northern and Southern African students study as well. And guess what. All the bad stuff you hear on the news is only a fraction of reality. The opposite was true. We cycled through the most beautiful landscapes, over mountains, through desserts, pass elephants and giraffes with children running after us screaming "I LOVE YOU". I had talks with local cyclists about politics, about life, about friendship and all other stuff. The people who joined the trip became like family to me. Of course you like some more than others, but the point is that you know everybody very well. And they all have different backgrounds; bankers, IT, students, in between jobs, mathematicians, psychologists etc. I learned more than I ever thought would be possible in such a short period. After returning back home I also noticed that I became much more confident and stronger. Conquering the physical challenges along the way made be mentally fit as well.

Study Abroad
The cycling trip was the finishing touch of my studies in European and International law. During my studies I studied in Tilburg, Sheffield, Maastricht, Stellenbosch, Aix-en-Provence, Beijing and Africa. I wrote my thesis while cycling from Cairo to Cape Town. Studying in these countries forced me to take a step back from "law" as a system. It made me understand that a "legal-system" is the result of the social context of each country. In South Africa the government had to deal with the inequality after the apartheid. There is a strong emphasize on freedoms in the South African constitution; freedom of speech, freedom of religion and equality. This was different in China where the focus is more on economic development. Both can be understood once placed

in the historical and social context of that country. Studying in these countries made me look at the legal system of my "own" country with different eyes. How did our law-system evolve into what it is today. And maybe there is not one system that is good for all because all these countries are too different from each other. Studying in China and South Africa provided me the chance to reflect my study subject from various viewpoints. It seemed something that could be valuable for other study subjects as well.

And so it started. At first I thought the idea would be too crazy to even discuss with other people. However everybody I talked to was enthusiastic. So we gave it a try. And we did it! In August of this year we finished the pilot! We cycled to knowledge in a team of 12 people. And now we are preparing the next edition and our main focus is how to integrate and improve the educational program so that it is one coherent program. Big History forms the backbone of the study program.

IV. Big History

In 2010 I decided to take the Big History course at the University of Amsterdam, given by Fred Spier and Esther Quaedackers. And this course provided the last piece of *The Study Road* puzzle. THE solution to all our questions regarding the educational part of The Study Road was there. If you want to learn about yourself and get ready for your future, you'll have to look back at the beginning. Observing and asking the question why? Especially in the challenging context of The Study Road it is important to learn that there are different cultural, historical, educational and motivational perspectives around the world. Big History combines all these. Maybe even more important than teaching the participants, is to trigger them. Big History invites people to put topics in perspective. In the context of *The Study Road* this may be the countries, the study subjects of the students or any topic that is of their interest. The backbone is there, but the body is shaped by the team. In that way *The Study Road* and Big History match once again. We want to offer the platform where interaction can take place together with the tools, however the direction will be chosen by the participants. Now I hear you thinking. How can you study Big History while cycling 12,500 km?

Well, we think it is actually easier and more fun on the road than learning from one location. You learn to understand "thinking Big History" in practice! How is this done? Lectures are provided at universities but also on the road. The framework of Big History will be introduced to the participants in Istanbul. The universities along the road will give a lecture about what they consider to be important. The lecture needs to be placed within the framework of the learning objectives that have jointly been developed in collaboration with Big History and the participating universities.

On the road, the participants are triggered to think about Big History through questions asked via a short movie. This question, related to the countries they cycle through, makes the participants think of the environment and cultures they cycle through. As a reply on the question the participants will make a short movie. All the movies will be posted on social media and *The Study Road* website. Everybody can watch these and anybody can learn along.

The next edition of *The Study Road* will be the pilot of the integration of Big History throughout The Study Road. We are curious for the reactions of universities and students. Since you are a member of the IBHA I am sure you know a lot about Big History. If you would have any suggestions for The Study Road and how we could integrate Big History we would love to hear them.

V. Conclusion

If you cycle *The Study Road* it is likely that you as well will go through ups and downs. You will climb mountains, cross desserts, have conflicts and face other situations that you cannot predict on forehand. It is hard work, both physically as mentally. But I think that these moments are actually most valuable. The moments that you think that you cannot do it. The moment that you decide that you cannot reach the top of that mountain. The moment that you get of your bike, that moment stops you and you found your limit. That moment will last maybe for one minute, maybe for 30 minutes. But then there will be a point that you decide that you will continue. And as you cycle on, you find that your mind is getting stronger because of these small moments that you experienced, something you cannot get from any book. And with this experience in your pocket you will go home, ready for an adventure in any direction that you choose.

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- The Study Brochure for The Study Road 2014

In the future, we'll all be big on history

After a shaky start, an innovative course is gaining popularity

BERNARD LANE

"A GENERATION of students taught Big History in high schools will start putting pressure on universities," says David Christian, a pioneer of this new way of telling the story of the universe and our place in it.

"I can imagine students coming to university and saying, yeah, but where are the Big History courses?"

Christian's own experiment with history on a grand scale began in 1989 at Macquarie University, and he acknowledges it must have seemed "completely lunatic" and an affront to the specialisation that gives the academy its claim to authority.

But the Big History course gradually took on its shape as a grand narrative. It begins with the universe 13.8 billion years ago, steps students through threshold moments of startling novelty such as the first stars and the emergence of homo sapiens, and invites us to contemplate the future of our complex global civilisation with its teeming megacities.

More than 120 schools in Australia want to join the Big History club next year; about 80 US schools used the course this year. With the backing of the philanthropist Bill Gates, who famously said he wished such a course had existed when he was at school, free online courseware of dazzling quality has been rolled out. There is also a captivating version for the general public — and for parents who would like to join their children on a voyage of discovery. The Big History project reaches out directly to those who are receptive, those who see the limitations of education as it is now delivered. This sidesteps the bureaucracy and builds pressure for change from the outside.

Another sign of this momentum was Australia's first Big History conference, staged last week where it all began — at Macquarie. Teachers keen to learn dominated the audience of more than 200.

"Big History is powerful pedagogical medicine," Christian tells them. "It can engage and empower students in a way that more traditional courses find it very difficult to do."

> 'We're in the early stages of learning our way around a new unifying story'
>
> DAVID CHRISTIAN

He cites a testimonial from one student at Dominican University of California: "Before Big History, I was afraid to look up at the night sky because it made me feel small and insignificant. But now it reminds me that we all have a place in this universe that is linked to everything else".

Even at the outset, when Christian concedes his Macquarie course was "a bit of a mess", students responded with a passion. And data gathering in the Gates-backed global project is in its infancy, but Christian has a hunch about why Big History is embraced by students, and why it can change them.

He suspects it has something to do with the way it enables them to make connections.

The new academic association for Big History defines it as the attempt "to understand in a unified, interdisciplinary way the history of the cosmos, earth, life and humanity". By contrast, Christian says, "modern education unwittingly sustains a sense of (meaninglessness) by teaching in fragments. We learn pieces of the puzzle — maths, history, biology — but there's no unifying map, and this creates the terrifying feeling that the puzzle has no edges, no shape, that we can never see the thing whole.

"There's a big problem with modern secular education — I don't think it is capable of offering a coherent vision of reality. And this is because we teach and organise knowledge in fragments."

Christian traces scholarly specialisation back at least to the nineteenth century, when the academy had to contend with "a tsunami" of ever-increasing knowledge. This response brought its rewards, and as a scholar whose first book dealt with vodka and the Russian peasantry, Christian is well placed to sing the praises of intensely focused research.

But if religion and spiritual "origin stories" were weakened as a source of big explanations, pseudoscientific doctrines such as social Darwinism made many scholars shy away from so-called "grand narratives". Scientists insisted that the data speak for itself.

But a long line of philosophers and writers have given anguished expression to a sense that the new world of science and technology lacks meaning and purpose.

It's a complaint that Christian saw acted out on stage recently in the Sydney Theatre Company's production of *Waiting for Godot*.

"It's a world without maps, without direction, it's a world without enchantment, it's a world in which there seems to be no philosophical or moral coherence, and there's all the time a sense of something missing, or something waited for that may never come," he says. Christian acknowledges that one response is to say that what we call meaninglessness is intrinsic to a world based on science, rather than superstition, and that we should simply "get used to it, live with it — that's our job".

"But I have to say I think there's an alternative which is much less familiar, and much more hopeful — it is that we're in the early stages of learning our way around a new unifying story which will have its own forms of enchantment."

He believes Big History can serve as a modern origin story for humans united beyond their often warring tribes — "the first origin story that will work for humanity as a whole, open to improvement, not dogmatic, and constantly being adjusted to take account of the evidence".

Christian hopes that within 20 years Big History will be a core part of curriculum in most schools and universities around the world.

"It won't replace existing courses — this is not a pedagogical coup d'etat — it will sit alongside them and it will connect them, and it will help students and researchers see the synergies that are at the moment so hard to see

JAMES CROUCHER

David Christian at Macquarie University, where he pioneered the Big History course that has now become an international hit

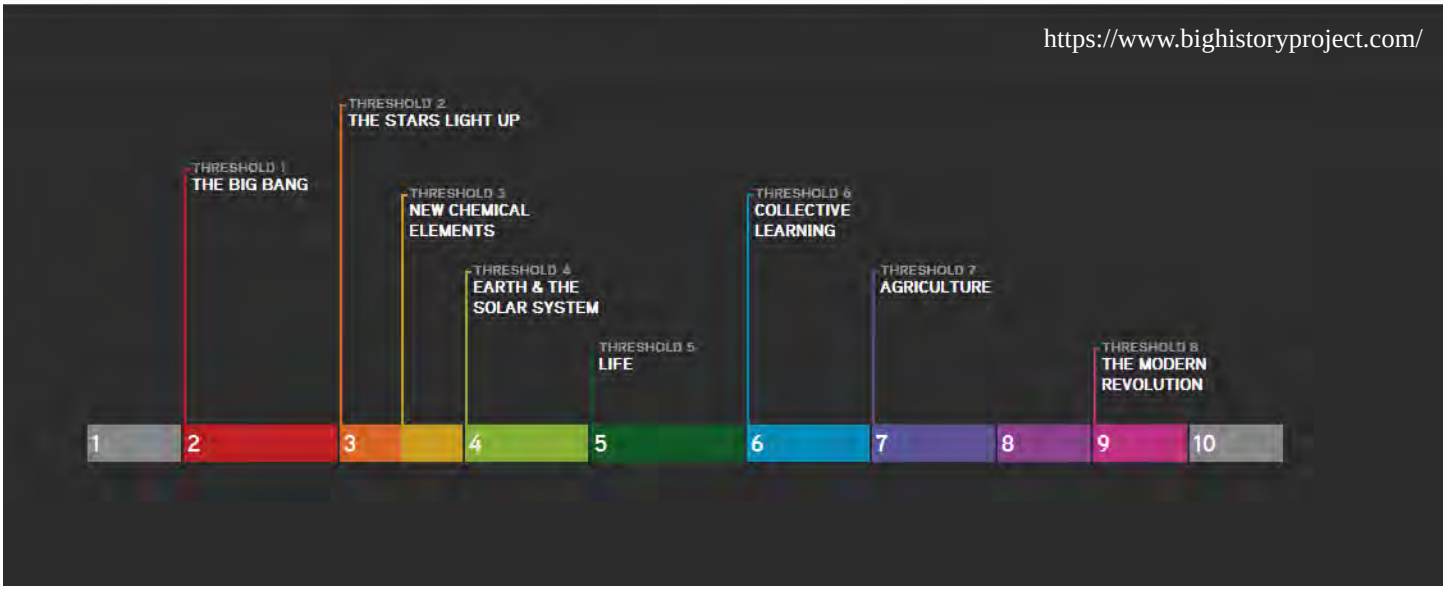
BIG HISTORY PROJECT UNITS CONSOLE 3 COMMUNITY

1 WHAT IS BIG HISTORY?

because of specialisation." Our foreshortened sense of time also obscures a truth of educational tradition. We do not see how unusual it is for classroom instruction to be based on a Babel of disciplines rather than a unifying narrative. "I suspect that for all the history of humanity, education was built around origin stories — except for the past 200 years, when suddenly they vanished, they ceased to be respectable," Christian says. "Really, Big History is not new; it's a very old thing. We need to rediscover it."

He quotes a US student from Maine who took the Big History course: "After this long, incredible voyage of exploration I have a new-found sense of what the universe is. I've learned that we're all part of the global future and I can make a difference in my life as well as the lives of others. My role is now to change my ways and respect this beautiful planet that granted us life, and to get others to join me."

https://www.bighistoryproject.com/



CALL FOR PAPERS

INTERNATIONAL BIG HISTORY ASSOCIATION CONFERENCE

AUGUST 6 - 10, 2014

DOMINICAN UNIVERSITY OF CALIFORNIA

SAN RAFAEL (SAN FRANCISCO BAY AREA), CALIFORNIA

TEACHING AND RESEARCHING BIG HISTORY:

BIG PICTURE, BIG QUESTIONS

DEADLINE FOR ***PAPER*** / ***PANEL*** SUBMISSIONS IS FEBRUARY 10, 2014

The International Big History Association (IBHA) defines its purpose as "to promote, support and sponsor the diffusion and improvement of the academic and scholarly knowledge of the scientific field of endeavor commonly known as "Big History" by means of teaching and research and to engage in activities related thereto."

Article 2 of the IBHA Articles of Incorporation.

The theme for the 2014 conference is "Teaching and Researching Big History: Big Picture, Big Questions." The conference seeks to continue the dialog begun at the first IBHA conference in 2012. In addition IBHA seeks to create a forum for the articulation, discussion, and distillation of questions central to Big History. Among the topics that are to be addressed at the conference through a series of panels, roundtables, and discussions are:

- *Big History and energy*
- *Big History in education*
- *Big History pedagogy*
- *Big History scholarship*
- *Big History research agenda*
- *Evolution of complexity*
- *Identification and analysis of thresholds*
- *Continuity and Contingency in our Universe*
- *Big History: interdisciplinary, multidisciplinary, or trans-disciplinary?*
- *Big History and the future*
- *Big History and meaning*
- *Big History outcomes and assessment*
- *Politics and Big History*
- *Little Big Histories*

International Big History Association

Along with regular panels and roundtables, presentations might consist of:

- *Question and answer sessions – where Big Historians will be able to answer questions and discuss research questions that are worth pursuing*
- *Brainstorming sessions – with very short, provocative papers*
- *General discussion panels – where different points of view about Big History can be addressed in 5 minute increments, specifically addressing the different cultural perceptions of Big History*
- *Workshops – where participants will view short film fragments and other art forms chosen by Big Historians, and presentations on Big History from the artistic point of view from artists, musicians, and storytellers*
- *Conference roundup – with a keynote address that summarizes the most important things outcomes of the conference*

We encourage proposals on any topic related to Big History. A select group of papers will be included in a compilation of Big History Research that will be published after the 2014 conference.

The time limit for presenting papers will be 20 minutes, and the deadline for submitting papers to the session moderator is three weeks in advance of the conference. Individual paper proposals must include a 250 word abstract with the title of the paper, name, institutional affiliation, e-mail address, phone and fax numbers, and brief curriculum vitae, all integrated into a single file, preferably in MS-Word. Proposals for complete sessions or panels must contain the same information for each participant, as well as contact information and a brief C.V. for the moderator if you suggest one. (The program committee can help find moderators, if necessary.) Please submit your ***paper*** or ***panel*** proposal by clicking on one of these links, which allow for submission information. The deadline for paper and panel submissions is February 10, 2014.

All presenters at the conference must be members of IBHA. Presenters may become members at www.ibhanet.org and will need to do so prior to registration for the conference.

The IBHA Conference will convene on the campus of Dominican University of California in San Rafael, which is located twelve miles north of the Golden Gate Bridge. Attendees will have the option of selecting from one of several hotels in San Rafael and the surrounding area or staying in on-campus accommodation.

San Rafael is a wonderful destination in Marin County surround by woods and beaches. For all things San Rafael go to http://www.sanrafael.com. For a complete guide to San Francisco and its many attractions, visit http://www.sanfrancisco.com/. And if you have more time to explore the larger Bay Area, see http://www.visitcalifornia.com/Explore/Bay-Area/.

Please find more details on the conference at www.ibhanet.org. We hope you can join us for this fantastic second IBHA conference!

Edgehill Mansion, Dominican University of California

Program Committee: Mojgan Behmand, Cynthia Brown, Lowell Gustafson, Fred Spier, and Joseph Voros

Transportation to/from San Rafael

Flying into SFO
We suggest taking the Marin Airporter from SFO to Marin and disembarking at the Central San Rafael Transit Center. Approximate travel time is 1.5 hours. Buses pick up passengers at SFO every 30 minutes, on the hour and half-hour, beginning at 5:00 AM. The last bus of the night departs from SFO at midnight. Fare is currently $20. http://www.marinairporter.com/schedules_sfo_to_marin.html
From the Transit Center in San Rafael, there are taxis available to take you to your hotel. If you are staying at the Four Points by Sheraton in San Rafael, it is approximately 3.3 miles from the Transit Center to the hotel.

Flying into OAK
We suggest taking the Sonoma County Airport Express to Marin and disembarking at the Central San Rafael Transit Center. Fare is currently $26. Please refer to the Airport Express website for travel times and pick-up times. http://airportexpressinc.com/schedules.php
From the Transit Center in San Rafael, there are taxis available to take you to your hotel. If you are staying at the Four Points by Sheraton in San Rafael, it is approximately 3.3 miles from the Transit Center to the hotel.

Hotel
Four Points by Sheraton
1010 Northgate Drive
San Rafael, CA 94903

Central Reservations 1-800-325-3535
Hotel Reservations 1-415-479-8800

Callers should identify themselves members of “DU-IBHA” arriving on Wednesday, August 6th and departing Sunday, August 10th, 2014 to secure the special rate and receive their confirmation number. Callers should have a credit card ready to guarantee reservation.

Discounted Rate: $114 (by 5pm local time, June 13th, 2014)
Group Rate: $139 (by 5pm local time, July 11th, 2014)

Reservations may be cancelled without penalty up to 24 hours prior to arrival.

Two Big History Songs

by Joshua Gallup

Until a few years ago, I was fortunate to be a school teacher in a 4th and 5 th grade classroom. My favorite subject to teach was history, which in the curriculum standards was referred to as social studies.

A number of years ago, I met Walter Alvarez in a bluegrass group where friends gather to play music once a week. Playing music with Walter Alvarez has always been, and still is, a real pleasure. He is an unusually warm and generous man.

Being a musician and a lover of history gave me an opportunity, which I could not resist. When Walter offered me a chance to take his Big History course at UC Berkeley, I jumped at the chance. During that semester there were a number of assignments in which I utilized my various interests.

The first song was 'It All Started With a Bang', which was an attempt to accomplish the same kind of impossible task of covering everything as the course itself. Please click here to hear the second song, "Anthro-psychic-mathe-cosmo-homo-geo-guistic-ology'. This one is really directed at (and dedicated to) Walter Alvarez. He did a marvelous job presenting the history of everything that ever happened in the universe and beyond in s single semester. That semester will always hold a big place in my heart.

Please click to listen to

ANTHRO-PHYSIC-MATHE-COSMO-HOMO-GEO-GUISTIC-OLOGY
Copyright by Josh Gallup

We know how it all started v 1
Even though we weren't around
We know how old the rocks are
By just looking at the ground

The forming of the cosmos v 2
Used to make no sense to me
But now I know it all
Cause it was taught to me

Anthro-Physic-Mathe-Cosmo-homo-geo-guistic-ology
So now I know I know it
Due to Big, Big History

A hundred million years v 3
Before the Bronze Age would begin
Hydrothermal vents
On an ancient ocean ridge

Spewed out copper v 4
That the ancients mixed with tin
I don't really get it
But I know I'll learn it in…

Anthro-Physic-Mathe-Cosmo-homo-geo-guistic-ology
So now I know I know it
Due to Big, Big History

From the age of reason back *bridge*
To the age of rocks
If you really listen you
Can hear the boulders talk

Anthro-Physic-Mathe-Cosmo-homo-geo-guistic-ology
So now I know I know it
Now I think I know it

Now I hope I know it…..
Due to Big, Big History

IT ALL STARTED WITH A BANG

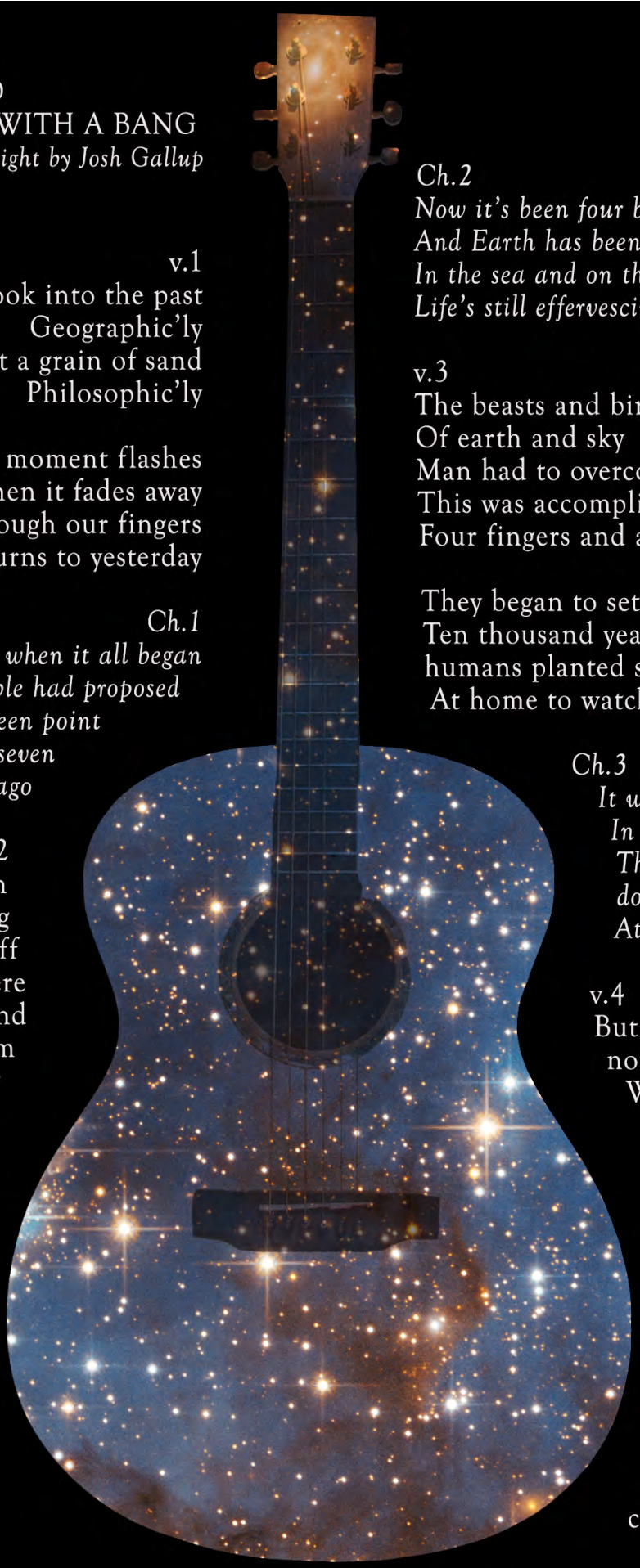
v.1
As we look into the past
Geographic'ly
We are but a grain of sand
Philosophic'ly

Every moment flashes
And then it fades away
Slipping through our fingers
It turns to yesterday

Ch.1
We know when it all began
Cause Hubble had proposed
That it was thirteen point seven
Billion years ago

v.2
It all started with a bang
And then took off from there
Hydrogen and helium
Went swirling everywhere

The gasses turned to masses
Of dust and cosmic storms
From these spinning discs
Planetesimals were formed



Ch.2
Now it's been four billion years
And Earth has been progressing
In the sea and on the land
Life's still effervescing

v.3
The beasts and birds
Of earth and sky
Man had to overcome
This was accomplished with
Four fingers and a thumb

They began to settle down
Ten thousand years ago
humans planted seeds and stayed
At home to watch them grow

Ch.3
It was in the age of bronze
In twelve hundred BC
That tin and copper melted down
At twelve-sixty degrees

v.4
But Visigoths from way up north
With catastrophic flair
Finished off the Bronze Age & it's
Gone downhill from there

In these last 1200 years
Have humans made advances?
Will it all end with a bang?
I guess we'll take our chances.

Walter amd Millie Alvarez; Joshua Gallup
Photo by Barry Rodrigue

Enlarging The Scope Of History

By Carolyn Shea

Evergreen (the alumni magazine of The Evergreen State College)

Barry Rodrigue, a 1974 graduate of Evergreen State College, has worn many hats so far in his life: seaman, peace activist, journalist, folk-life researcher, and geographer to name a few. These experiences have shaped his career as a trailblazer in Big History, a burgeoning academic field that has Evergreen roots.

Perhaps the ultimate interdisciplinary study, Big History seeks to comprehend the cosmos in a unified and scientific way—as a 13.8-billion-year saga of everything from the Big Bang and the evolution of life on Earth, through the rise of Homo sapiens, all the way up to the present.

An associate professor of arts and humanities at the University of Southern Maine (USM) in Lewiston, Rodrigue is a founder and the international coordinator of the International Big History Association, which is bringing scholars around the world together to move the field forward.

Barry Rodrigue (center) in the mountains of Chechnya with Khusayn Yakhikhanov of the Chechen State University (left) and Magomedkhan Magomedkhanov of the Dagestan Scientific Center, Russian Academy of Sciences (right). Photo by Adlan Sagaipov in February 2011.

Rodrigue and others give credit to former Evergreen faculty member Siegfried Kutter as being a pioneer of the field. During the 1970s and '80s, Kutter wrote "The Universe and Life: Origins and Evolution," an interdisciplinary text that was influential in Big History's founding.

Big History has won backing from philanthropist and former Microsoft CEO Bill Gates. Several years ago, he listened to a series of college-level Big History lectures and found them so engaging that he's funding the Big History Project, a free, web-based instructional model for high school students. "I really like how the course challenges students to wrestle with big questions," he has said, "questions like how different time scales affect our perspective on history, how language transformed humanity, and what it means to be human."

Another resource called ChronoZoom is also helping to expand Big History's reach. Funded and supported by Microsoft Research Connections in collaboration with several universities, the innovative online visualization tool is dedicated to teaching the subject and facilitating interdisciplinary research.

Big History is based on the notion that learning about the past should encompass a larger perspective than the narrow confines of nationalism and human activity. It pulls together independent disciplines—physics, chemistry, biology, the study of ancient civilizations and contemporary human history—to come up with a holistic view of our interrelated universe.

Rodrigue learned about the field at a conference in 2004, when he was developing a basic course in world history at USM. From then on, he became more involved in organizing the development of Big History, which he now also teaches at the university.

Rodrigue, whose experiences have taken him from Alaska and Nicaragua to China, Siberia and beyond, studied molecular biology at Evergreen with faculty member Betty Kutter. He intended to go into

medicine. When he was a student, he'd already been a medic during the Vietnam War (which he came to oppose), stationed at Alaska's Elmendorf Air Force Base and doing mostly civilian rescue work. "I felt good about the medical and rescue work I'd done," he said.

In 1974, that path was forever changed when the then-25-year-old Evergreen senior won a prestigious grant from the National Endowment for the Humanities to do ethnographic fieldwork in Alaska. With the funding, he spent seven months in an Inuit village, recording folk tales and oral traditions.

During his time there, he gathered interviews, oral histories, documents, and photographs. After wrapping up his primary research, he compiled the materials into a study of the indigenous people of the Bering Strait region and Southeast Alaska.

A native of Maine, Rodrigue ended up living in Alaska for two decades, conducting ethnographic research in rural communities throughout the state. In 1976, he launched Archipelago, a regional and community journal of material submitted by people from Southeast Alaska, the southern Yukon Territory, and northern British Columbia. Through the course of publishing the journal, he said, "I discovered that what people loved most and sent in most were songs and poems." This prompted him to begin documenting regional folk music, which he published in two volumes of the "Panhandler Songbook." The Panhandler songbooks took their name from the "panhandle" of Southeast Alaska.

He also produced a three-volume record collection called, "The Southeast Alaska Folk Tradition." Part of the legendary Folkways Records now housed at the Smithsonian Institution, the treasury is a cultural history of the region in music, song, and dialogue that includes accounts of episodes from Alaskan history, piano rags, blues, Native chants, and more.

A Fulbright scholar, Rodrigue earned a master's degree in history and folklore 19 years after graduating from Evergreen. He capped that with two PhDs, one in geography and one in historical archeology and history with a specialty in ethnic studies.

He's written numerous articles and books about human settlement in Alaska, the eastern borderlands of Canada and the U.S., and Big History.

A proponent of interdisciplinary studies and student-centered learning, Rodrigue has been at USM since 2000. He said the curriculum at the Lewiston campus "is intentionally modeled after Evergreen." He's involved his classes in organizing conferences and in archeological research that has added to the understanding of Maine's history.

To Rodrigue, Big History is the ideal vehicle for bringing people around the globe together. "I personally see it as creating a common background for all of humanity to understand how we fit in the universe. It creates an area for conflict resolution and peaceful, sustainable development."

Newsletter Response

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May we publish your comment?

- ◯ **No**
- ◯ **Yes**

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