

A Big Picture, Conceptual Introduction to Biology: EEB 122

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Each of us is connected through our parents and their parents and so forth to a first life form which has no parent and is composed and derived from non-biological forms. So each of us is intimately connected through our genealogical history to the non-biological Universe! Indeed, each of us is connected in this way to the whole Universe!!! It is this type of conceptual, big picture thinking that pervades [Stephen Stearns' free video course EEB 122: Principles of Evolution, Ecology, and Behavior](#) at [Open Yale Courses \(OYC\)](#). Even though I do not think the separation between life and non-life is as clearcut as Stearns suggests, [Jeannie](#) and I thoroughly enjoyed our excursion into [Biology](#) with Stephen Stearns as our guide at OYC!

The Importance of Biology, Evolution, Ecology, and Behavior

Understanding biology is essential as civilization is inseparable from the great ecosystems upon which it is built and in which it is housed. Our future is inextricably linked to the always changing nature of the Earth-Biosphere system which provides our food and shelter. In EEB 122, we learned that the entire Earth has been sculpted by the biological [technology](#) we call “life“. At a more day-to-day human scale, medicine and health care are vital subjects in biology and in our economy (caring for the health of the ecosystem of cells, organs and their microscopic cohabitators known as “human” engages 9% of the economies in most [OECD](#) countries and nearly twice that in the USA). EEB 122 has a whole lecture devoted to medicine and more comments throughout the course.

[Evolution theory](#) has had a profound influence on modern thinking. From its nascent formulation by [Charles Darwin](#), the theory of evolution has itself changed (evolved!) substantially over its first 150 years. I found it particularly interesting to learn that the modern theory is quite different from what my culture-imbedded intuitions misled me to think. This course is eye-opening! Even if you disagree with some of the ideas of evolution (and who doesn't have some questions and concerns about this subtle subject which is itself changing), this course corrects some of our endemic misperceptions. For example, Stearns asserts in lecture 3 that the notion of “survival of the fittest” is wrong! I had no idea that that iconic “sound bite” is but a dead-end on the road to the modern theory of evolution!

It's not ignorance does so much damage; it's knowing so darned much that ain't so. —
Josh Billings

With current concerns about global warming and other stresses on our environment, ecology is a vitally important subject. The point is reinforced by the work of three of the recent winners of the [Buckminster Fuller Challenge](#) which deeply engages the subject of ecology. [The 2011 winner, Blue Ventures, conserves threatened marine environments.](#) [The 2010 winner, Project Hope, restores savannas and grasslands lost to desertification with a comprehensive program featuring cattle management.](#) [The 2008 winner, John Todd's Comprehensive Design for a Carbon Neutral World, restores the ecological devastation of the impact of mining in Appalachia.](#) The principles of biology

and ecology are essential to better understand and contribute to these and similar initiatives to improve our management of Earth's ecosystems while raising the standard of living of every human being. EEB 122 explains some of the vital principles that will underpin any such solution.

In summary, OYC's EEB 122 is an excellent introduction to the basic principles of biology needed to better understand medicine, health care, evolution theory, ecology, the behavior of organisms, and biological [technologies](#) such as the enterprising work of the [Buckminster Fuller Challenge](#) winners. Finally, and perhaps most importantly, EEB 122 gives a conceptually broad, biologically detailed introduction to one of the most enchanting visions of change ever developed: the theory of the evolution of species.

How We Used the EEB 122 Course Materials

Jeannie and I started watching EEB 122 around New Year's. We watch courses like this for edutainment. That is, we do not plan to become professional biologists, instead we watch video courses as a form cultural enrichment: How do biologists think? What do they know? What is the current understanding of evolution? I am deeply curious about how the world works. Video courses like EEB 122 are deeply enriching in this regard. It took just over five months of watching one 50 minute video approximately every four days to work through the 36 videos in the course. We find that watching videos more frequently than that gives a rushed feeling and a sense of information overload. For us, watching less frequently sometimes results in losing "presence" to the thread of the course and feels less coherent.

The course includes a syllabus and two exams with solutions (we did not look at the exams). OYC includes a summary (very useful) and reading assignment with each video. There is also audio, but Stearns' use of slides means that video is the best way to enjoy the course. The transcripts of the lectures were very helpful when I wanted to better understand a lecture or to get the spelling of a name or technical term. The videos are also collected in a [YouTube playlist with 36 videos for 27 hours and 28 minutes](#).

The video lectures are self-contained and are so good that we did not get the textbook. Sometimes, we followed up on a lecture with [Wikipedia](#) or other sources to learn more. The video style of OYC is to use just one camera with minimal editing. The camera does pan to try to capture Stearns' slides and gestures and that is effective (with a big screen and moving close to it, we were able to read almost every slide — sometimes this involved squinting). Certainly, it would be much better if an electronic version of the slides were included with the course, but the video was rich enough that not having the slides was only a minor disadvantage.

Downloading the videos (thankfully) was easy: use a "DocumentRoot" of <http://openmedia.yale.edu/projects/> and then append the rest of the filename which I deduced by mousing over the download link (or viewing the page source code). Once we had the video downloaded, we could watch it on demand and use the remote control to pause or "rewind" by 15 seconds or 1 minute or whatever we needed in case the phone rang or our minds wandered. [As I mentioned before, streaming video is "bad" for watching video courses](#).

A Survey of other Introductory Biology video courses

There are several other introductory biology video courses in the [Open Educational Resources \(OER\)](#) ecosystem. We watched and enjoyed the excellent [video course at MIT OCW, 7.014](#)

[Introductory Biology with Graham Walker \(biochemistry, molecular biology, and genetics: 23 lectures\)](#), [Martin Polz \(molecular evolution: 2 lectures\)](#) and [Penny Chisholm \(ecology: 11 lectures\); \(34 videos totaling 25 hours 57 minutes plus 2 audio lectures\)](#). Graham Walker got carried away with his mastery of biochemistry once or twice, but he really got across the fluidity of knowledge in biology. Penny Chisholm's portion of the course on ecology is in some ways better than Stearns' treatment as it is longer and more thorough (Stearns only dedicates 8 lectures to ecology). From the perspective of edutainment, the MIT lectures cram in too much information. We got a lot out of it despite the occasional pangs of overload. Of course, one can pause the video to take notes and reference [MIT OCW's](#) extensive supplementary material and Wikipedia. 7.014 is a good course, but to fully enjoy it either a strong biology background or a commitment to study is necessary (unless you enjoy sipping from fire hydrants).

OCW's 7.014 is complementary with EEB 122 (especially the ecology parts). For a deeper understanding I recommend watching both. Start with EEB 122 as it is less demanding. Unlike the 7.014 videos, the EEB 122 videos gave me the feeling that I had a good conceptual overview of the subject after each lecture. Stearns' EEB 122 is effective!

I found a some other introductory biology video courses worth mentioning even though I haven't watched them. I am very interested in [MIT OCW's 7.012 Introduction to Biology \(34 videos totaling 27 hours 45 minutes\)](#). Compared to 7.014, it drops ecology and adds coverage of neurobiology, molecular medicine, and cancer (both OCW courses have roughly equal coverage of biochemistry, molecular biology, and genetics). 7.012 is on my TODO list: with 7.014 and EEB 122 behind me, I am emboldened to learn biochemistry, molecular biology, and genetics in more detail!

[Berkeley's YouTube channel](#) has a couple of versions of their introductory courses on "General Biology". They are [Bio 1A \(39 videos totaling 32 hours 14 minutes\)](#) and [Bio 1B \(41 videos totaling 34 hours 41 minutes\)](#). The courses are team taught by three or four professors each term. I watched a few seconds here and there of several of the Berkeley videos and they are very well produced. The Berkeley biology courses seem to be structured more as a survey of important topics than as a conceptual, principles-based overview (which is the strength of Stearns' EEB 122).

Berkeley has two other introductory biology video courses which are interesting. [Biology 1AL: General Biology Laboratory \(which accompanies Bio 1A with 12 YouTube videos totaling 16 hours 6 minutes\)](#) looks interesting enough that I put it on my TODO list. Finally, I have watched a few of the videos in [Marian Diamond's excellent course Integrative Biology 131 – General Human Anatomy covering the functional anatomy of the human body as revealed by gross and microscopic examination \(Fall 2005 with 39 videos totaling 32 hours 25 minutes\)](#). Before choosing a course, it can be worth checking [Berkeley's webcast site](#) to look for related courses or other versions of these courses.

[The Khan Academy also has an excellent archive of topical biology videos](#). Another that might be very interesting is [UCLA's Life Sciences 15: Life, Concepts and Issues \(19 videos totaling 19 hours 48 minutes\)](#). There are other biology courses out there, but this survey is already adequate to get started. Please let me know your thoughts about any interesting video courses that you watch.

Detailed Résumé of EEB 122: Principles of Evolution, Ecology, and Behavior

The 36 lectures are divided into three sequential thematic sections: Evolution (23 lectures), Ecology (8 lectures), and Behavior (5 lectures). Because the themes interweave, each is discussed throughout

the course. I posted summaries or more accurately thoughts about each lecture to [my wall on Facebook](#). What follows is my distillation of those notes plus some commentaries, references, fun facts, a few hypotheses and other nuggets for thought. Hopefully they give a feel for the course and the subject. They might help you find parts of special interest to watch or at least enjoy EEB 122 vicariously through my comments.

Evolution

1. [The Nature of Evolution: Selection, Inheritance, and History](#). Introduction to microevolution (at the time scale of organisms: natural selection & drift) and macroevolution (at geologic time scales: there is one tree of life possibly excepting viruses). History of evolution: Aristotle had some thoughts, but mostly it “formed” in the 19th century. Natural selection only happens when there are variations in reproductive success resulting from variations in heritable traits.
2. [Basic Transmission Genetics](#). A summary of genetics in one lecture! Both MIT’s [7.012](#) and [7.014](#) cover genetics much more extensively, but Stearns’ overview is remarkable for its big picture clarity.
3. [Adaptive Evolution: Natural Selection](#). Stearns says “Adaptive evolution is about a design for reproductive success.” [Herbert Spencer](#)’s idea of “survival of the fittest” is wrong (Note: this concept was not part of the first several editions of Darwin’s magnum opus, [On The Origin of Species](#))! I was very surprised by this revelation. I checked with one of my [schoolmates](#), [Rich Wilkens](#), who is now a professional biologist and he corroborates that “survival of the fittest” is not incisive in modern evolution theory. I think the problem with “survival of the fittest” is that the term “fittest” is ambiguous and misleading. Fittest right now or in 100 or 10,000 years? Fittest with respect to this ecosystem or local population? Before or after the flood, fire, or other environmental change? Before or after that “invasive” species arrived? This course is starting to get interesting: one sacred cow in the popular mythology of evolution is slain!
4. [Neutral Evolution: Genetic Drift](#). I was surprised to learn that the complexity of [meiosis](#) and its fairness (50% chance for a gene to propagate) may have evolved to protect against “[meiotic drivers](#)” (genes which “find” ways to increase their probability of propagating). It stretched my mind to think how the rules of genetics may have themselves evolved. And to imagine the effects of neutral drift. Evolution and the genetics mechanisms it entails are complex: this is no simple mechanistic theory: there are complex effects of [synergy](#), [syntropy](#), and [randomness](#) operating here!
5. [How Selection Changes the Genetic Composition of Population](#). Asexual [haploid \(one set of chromosomes\) genetics](#) can change faster than sexual [diploids \(two sets of chromosomes\)](#)! I didn’t even know that haploid species existed. There are [polyploids \(many sets\)](#) too!
6. [The Origin and Maintenance of Genetic Variation](#). Mutations.
7. [The Importance of Development in Evolution](#). Development is, in one view, the [genotype-phenotype map](#). Genes leverage the biochemical infrastructure of the [zygote](#) rather than specifying all details explicitly! It made me wonder: are genes just a library for protein synthesis supporting an always dynamic cell with its other critical biological infrastructures ([organelles](#), etc.) altogether forming a synergetic resultant: a [telos](#) of ever-unfolding life? I first glimpsed the idea of life as [teleological](#) from [Zann Gill’s Google Tech Talk on Innovation](#). There are similar ideas in [Teilhard de Chardin’s The Phenomenon of Man](#). Biology now has a dawning awareness of these issues!

8. [The Expression of Variation: Reaction Norms](#). The biologists way of addressing the Nature vs. Nurture debate is with [reaction norms](#). They provide an analytical framework for measuring and depicting how [phenotypes](#) respond to environmental forces. It's illuminating that biologists can measure these influences!
9. [The Evolution of Sex](#). Take away from this video: we have no idea why sex evolved, but it is a "good" thing from an evolutionary perspective. Stearns said: "[I]f you look at the [Tree of Life](#), what we see is that the asexual types are up on the twigs and they have sexual ancestors". Wow! I thought the asexuals were whole branches on the tree of life, not just the twigs! I wondered if [archaea](#) and [bacteria](#) have sexual ancestors? [Rich Wilkens](#) suggested they swap so much DNA they can overcome [Muller's ratchet \(accumulation of deleterious mutations\)](#) without sex. The tree of life is more complex than I expected!
10. [Genomic Conflict](#). Our parts are in [genomic conflict](#)! Mother, father, and child have conflicting interests. Even our cells' organelles are in conflict with the organism itself. Yet fairness (in meiosis) evolved in a sea of multiple layers of "selfishness" and genomic conflict. That conflict persists: in genetics and in society. Genetics can inform social conflict resolution. An intriguing lecture: illuminating the deep role of conflict in its natural context!
11. [Life History Evolution](#). Stearns said, "that organisms age is actually the best evidence we have that it's the replication of genes, not the survival of organisms". Long life apparently doesn't matter much to evolution. More evidence that "survival of the fittest" is the wrong concept. The illustrative examples are the best part of this lecture: they highlighted the central role of tradeoffs.
12. [Sex Allocation](#). Issues about the ratios of male and female function.
13. [Sexual Selection](#). The Valentine's day lecture. Despite all of the research, my takeaway is that frightfully little is known about the evolutionary, ecological and behavioral causes of sexual dimorphism (the differences in the male and female forms). Some fascinating illustrative examples and theories are discussed. This lecture is filled with the ambiguities of cognitive dissonance: the food of good thinking!
14. [Species and Speciation](#). Speciation is far more complex than one might think: Stearns cites seven "good" definitions of [species](#) that biologists use! Interesting, we now know many examples of [cryptic species](#) which look morphologically identical but are genetically distinct! Even biology needs to be wary of a "hardening of the categories"!
15. [Phylogeny and Systematics](#). Stearns shows how to build a [tree of life](#)! An amazingly simple process: but combinatorially incalculable! We will never get the tree of life precisely right. It will simply have to be good enough for "practical" use.
16. [Comparative Methods: Trees, Maps, and Traits](#).
17. [Key Events in Evolution](#). Stearns starts with the definition of life: "life is basically anything that has the properties of multiplication, variation in heredity, plus metabolism. ... it is likely that metabolism came first". The transition from abiotic organic chemistry to the first metabolizing life forms is the first big transition. Another is the transition from [prokaryotic](#) to [eukaryotic](#) life. The concept of hierarchy seems to be central to the evolution of complexity.
18. [Major Events in the Geological Theatre](#). A remarkable lecture on how life changed the Earth and made the soils. The Sun's [irradiance](#) & warmth has been increasing which in turn influenced life.

Asteroids and [tectonic drift](#) have also influenced life. Major and minor catastrophes punctuate Earth's history. Think 2400 foot high tsunamis and earthquakes of magnitude 10! [The 2011 9.1 quake in Japan](#) is the kind of relatively minor event that happens several times a century! Inspired by this lecture, I compiled a list of the frequency of major geological catastrophes (adding some data from Wikipedia to what Stearns says in the lecture):

- Major earthquakes: several per century ([there have been 5 quakes of at least magnitude 9 since 1952: about 1 every 10-30 years](#)).
- Major volcanic eruptions: one per century ([14 in past 1000 years](#)).
- Gigantic eruptions: one per 10,000-100,000 years (there have been [4 VEI 8+ eruptions](#) in the last million years which is one per 200,000 years, but Stearns's might include some large VEI 7 quakes).
- Undersea landslide: [one or two every 100,000 years](#).

19. [The Fossil Record and Life's History](#). Why have some species, the so-called [living fossils](#), been "fixed" for so long (such as [Coelacanths](#), [Onychophorans](#), [Priapulids](#), [Liverworts](#), etc.) whereas almost all the rest are extinct? Stearns says it is an open question. Stearns ends the lecture with this thought: "We're currently in the middle of a big anthropogenic extinction crisis ... Geological processes have caused many extinctions of entire communities, wiped them completely off the face of the earth, and life has re-generated new ones again and again and again and again."

20. [Coevolution](#). [Wolbachia](#) is a cool bacteria that has co-evolved with [arthropods](#) and [Nematodes](#) to change the sex of its hosts! [Corals](#) farm [dinoflagellates](#) for energy from photosynthesis; [leafcutting ants](#) farm [fungus](#). Both have farmed for longer than humans! Stearns argues that co-evolution & co-adaptation are more or less the same process.

21. [Evolutionary Medicine](#). Fascinating! Our evolutionary history plays a significant role in shaping how our bodies respond in medical situations. For example, modern sanitation has eliminated parasitic worms from our bodies and that may be responsible for many of our auto-immune diseases like asthma, allergy, MS, arthritis, colitis, & diabetes.

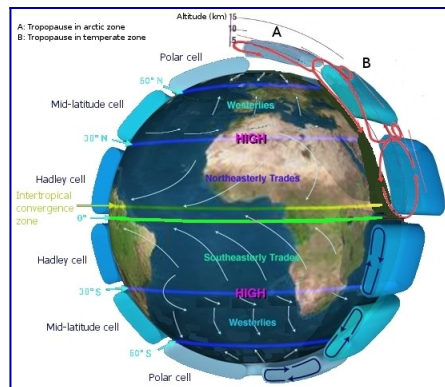
Vaccines are [technology](#) built on the theory of evolution! As Stearns explains it: "what an attenuated vaccine is, is a pathogen that would cause a serious disease, but it's been evolutionarily changed, so that it's attenuated."

Stearns said, "[T]here are actually more people who were dying of bacterial infections that they acquired in hospitals than of [AIDS, flu, breast cancer] combined." Then he observes, "There's about a ton of bacteria per acre in a cropland; that's about 10^{17} bacteria." Among that enormous biodiversity many strains are resistant to antibiotics. Human use of antibiotics selects for drug resistant strains. Stearns' cited the Danish experience where [Vancomycin](#) was banned in agriculture (rural farms) and there followed a dramatic reduction in antibiotic resistance in hospitals (in cities). Which suggests that agricultural use of antibiotics is partially responsible for drug resistant infections of hospital patients! The city and the country are connected in one system with evolutionary processes entangling their fate!

Evolutionary theory has become critically important for the [technology](#) of medicine!

22. [The Impact of Evolutionary Thought on the Social Sciences](#). Another fascinating lecture: Stearns presents evidence and counter-evidence to the thesis that humans are partway through a major evolutionary transition from more individualistic (selfish) to more collective (group) behavior. I do not have time or space to do this lecture justice here, I hope to dedicate a future essay to this exciting topic.
23. [The Logic of Science](#). Another deep, insightful video from Stearns on the nature and being of science. Stearns considers what is knowledge (epistemology), the “debate of alternatives”, the method of multiple working hypotheses, falsifiability, strong inference, scientific revolutions, and philosophy of science. Again, I do not have time or space to do this lecture justice, I hope to write a future essay on the subject.

Ecology



24. [Climate and the Distribution of Life on Earth](#). This broad lecture on Earth’s climate introduces the topic of ecology. Stearns says “You can think of ecology as providing the theater in which the evolutionary play occurs; that’s a metaphor from [Evelyn Hutchinson](#).” Stearns gives a good description of how [Hadley Cells](#) and the [Coriolis effect](#) work to affect climate (Stearns + Wikipedia = understanding!). And how these effect the [biomes](#).

Stearns gives a remarkable description of El Niño: The Hadley cells and Coriolis effect produce gyres in the northern and southern hemispheres which come together in the Pacific at the equator and push water to the West. The result is that about 1 meter of warm water gets piled up between Guam and the Philippines. This is the normal situation; it is called La Niña. About once every 10 or 11 years, the pattern breaks down and El Niño ensues: the wall of 1 meter high water starts flowing eastward. Which squashes the upwelling of the normal ocean currents. Without upwelling bringing nutrients to the surface, the great fisheries of the eastern Pacific collapse, fisherman lose their livelihood, birds die of starvation, and the weather changes. It is a big effect. It is normal: it happens about once every 10 years.

25. [Interactions with the Physical Environment](#). Physiological ecology studies the adaptations of an organism to its environment (temperature, pH, water availability, etc.). Stearns said, “[niches](#) aren’t pre-existing molds, out there, into which organisms are poured. They are the products of an evolutionary play that is creating the theater while it’s writing the roles. And while the play is running, evolution is rewriting the script, it’s remodeling the actors, it’s putting in new actors, it’s redesigning the sets, and it’s renovating the theater. It’s a very long running play, it’s got a lot of characters. So if you think of a niche as static, essentially what you’re doing is you’re just taking a snapshot out of a video.” Fun fact: Bears do not hibernate, they just sleep for a long time!
26. [Population Growth: Density Effects](#). Stearns explains “populations are held in check by lots of things. They’re not just held in check by food. They are held in check by breeding sites, by space,

by lots of limiting resources. As populations increase in density, the individuals shift along [reaction norms](#). They reduce growth, they are smaller; when they become adults they experience more variation in adult size; they have lower fecundity and more variation in fecundity; and they have higher mortality and more variation in mortality, as they encounter density dependence.” [Penny Chisholm’s 7.014 lectures on population growth](#) go into more depth on exponential growth quantitatively. They are an excellent supplement to this lecture.

27. [Interspecific Competition](#). The [competitive exclusion principle](#) does not always hold because coexistence is possible. Stearns argues this with the [Lotka-Volterra equation](#). But the slides weren’t clear enough for me to get it. Interesting point: plants will always be found in nature growing next to other plants with which they can more easily coexist.

28. [Ecological Communities](#). The history of a community matters a lot (history is a key concept Stearns has emphasized repeatedly). To some extent all communities are assembled from migrant species, so invasive species are normal! It takes a long time for a community to stabilize after major changes. For example the Amazon, let alone eastern forests, have not yet reached equilibrium from the last ice age that receded 12,000 years ago!

29. [Island Biogeography and Invasive Species](#). Main point of the lecture: Geography is very important in ecology! Good lecture, and not just because of the weird costume the professor is wearing! Stearns said, “there is a pedagogical message in this costume, and that is if you can’t play like a child, you can’t be creative.” Sweet!

The [island biogeography model](#) is on the wane as the [Metapopulations](#) model supplants it by fixing a number of its problems. The world is fragmented ... it is spatially heterogeneous: “There are islands, there are mountains, there are lakes and oases ... what is determining biodiversity in a fragment? What happens when we break the world up?” The metapopulation theory involves a [stochastic](#) model of continual migration and local extinction as normal ecological behavior. It connects with [epidemiology](#) to give insights into disease spread. Fun fact: at 35,000 feet altitude over Antarctica, you will find baby spiders and fern spores at -70 degrees Celsius in deep hibernation but still alive!

30. [Energy and Matter in Ecosystems](#). [Biogeochemistry](#). As usual Stearns starts with the big picture putting ecosystems in the context of [biomes](#). This lecture fascinated me with its details: Open oceans are deserts. Currently Earth’s efficiency at converting sunlight into locally captured energy is very low <1%. Algae are our biggest sun energy harvesters. [Detritivores](#) are important! Stearns at least partially supports [Jeannie](#)’s thesis that the deserts in the middle east were caused by Humans: “So if we go to the Mediterranean, and we look at the impact of what the dairying culture did, on the Mediterranean—so people started keeping sheep and goats, and goats are incredibly efficient at removing brush and grass from the landscape—basically what the goats did is that they desertified the periphery of the Mediterranean, all the way around. They did it between about 5000 and 2000 years ago.”

More details: there are three large carbon stores: 750 Gtons in atmosphere, ocean surface 1000 Gtons, deep ocean 38000 Gtons. Humans are adding about 5 Gtons per year. Relatively small. Stearns points out that global warming is a small perturbation with respect to biological and geological history. Life will adapt to global warming. The question is will the changes be too fast for Humans to adapt? As I discussed in my [essay on technology](#), the risk of a [black swan](#) always looms. For example, if the [methane hydrates](#) currently stored in the deep ocean melt and are

released, the impact of global warming could easily change from being just a worry to a head on collision.

Humans have also had major impacts on the [phosphorous](#) and [nitrogen](#) cycles (humans are now responsible for about half of the global nitrogen cycle since the [Haber-Bosch process](#) was invented in WWI).

[140 gigatons is equivalent to 10 million trucks of dry nitrogen fertilizer that we are putting into the system with completely unknown effects.](#)

[— Penny Chisholm in MIT OCW's 7.012 video on Biogeochemical Cycles](#)

This lecture and OCW's 7.012 videos convinced me of the profound importance of biogeochemistry. I have not yet found a free video lecture course on biogeochemistry, let me know if you see one.

31. [Why So Many Species? The Factors Affecting Biodiversity.](#) This lecture addresses the challenges that exist between human value systems and biodiversity. 25% of the birds in the Pacific are extinct. The anthropogenic extinction crisis is killing off species between 100 and 1000 times what is seen in geological history. Stearns says “the impact of humans on the environment basically is a function of how many people there are on the planet, times the average amount that each of those people consumes, multiplied perhaps by some fudge factor to express good or bad behavior on the part of the humans. ... by way of introduction, I never want you to forget that the problem of human impact on the other species on the planet is not a problem that we can really solve with scientific research. We can only solve it by understanding the incentives that people encounter to have more babies, or fewer babies, and the incentives that they encounter to consume more or to consume less. This is a really tough nut.”

The science of biodiversity doesn't give strong arguments to preserve the environment, Stearns reports “Bob May showed that more diverse communities can be less stable. ... Since then there have been a lot of experiments. There isn't a convincing clear pattern.” Recent research does suggest that diversity is important in pollinator communities. So there is a strong economic argument to preserve the biodiversity of our pollinators because our agricultural system depends on it.

Stearns gives a strong warning against arguments that “biodiversity is important for maintaining everything that Nature gives us for free”. If we overstate the science and our ecosystems still haven't collapsed, we look like we are “crying wolf”. Stearns concludes “the issue that you could have a lot of ecosystem redundancy, which is buffering you from the extinctions that might otherwise be affecting ecosystem function, but at some point, if you've eliminated a lot of species, you will hit a limit at which there's no redundancy left, and at that point ecosystems start to collapse.” I liked Stearns' poignant observation: “the extinction crisis, and the meaning of biodiversity on the planet, is an interesting probe into our own nature and our own priorities. ... [it is] an opportunity to learn an awful lot about ourselves and about the Nature that we interact with. ... So it's not all pessimistic. It's simply a very deep-cutting, revealing situation.”

Behavior

32. [Economic Decisions for the Foraging Individual.](#) Introducing part three of the course. Stearns' focus is on the [behavioral ecology](#) view: “the evolved patterns that we see in behavior should reflect things that happen frequently to the organisms in their environment, and the way animals

behave should reflect the consequences of behavior for lifetime reproductive success.” Another field in the biology of behavior is the comparative view of behavior: how behavior evolved phylogenetically. Another is how behavior develops or is acquired; that is, the mechanistic underpinnings of behavior such as [neurophysiology](#) & [endocrinology](#).

33. [Evolutionary Game Theory: Fighting and Contests](#). Evolutionary game theory is an abstract analytical tool for thinking about, particularly, frequency dependent evolution of phenotypes. But it isn't directly testable with real biological examples. So it's just a tool to aide in thinking about how different strategies might work out.
34. [Mating Systems and Parental Care](#). An intriguing survey of various examples of variations in biology. Male seahorses have “brood pouches” where the female lays her eggs. Many other weird and wonderful variations on the theme are presented.
35. [Alternative Breeding Strategies](#). Evolution is about reproductive success. Once a dominant mating strategy develops, it is possible for “parasitic” mating strategies to develop. The lecture ties evolution theory, history, options, change and behavior together.
36. [Selfishness and Altruism](#). Stearns said, “[I]t is now widely accepted that kin selection does occur, and it can explain altruistic sacrifice.” Long-term individual self-interest and win-win mutualistic cooperation are alternative theories to explain selfishness & altruism. Several illustrative examples are discussed.

Conclusion

Whether you are looking for videos for edutainment, or to study biology in depth, or whether you watch just a few lectures of interest or all of them, EEB 122 is a great course! Stephen Stearns' big picture and conceptual approach to the principles of evolution, ecology and behavior make this course particularly apt for a comprehensivist like me who is interested in building a deeper understanding of how the world works. Too much of our educational system is focused on turning out specialists by building technical language barricades that divides us from each other and complicate cross-disciplinary understanding. Like [Physics C10/LS C70V at Berkeley](#), this course opens some of the vitally important principles of how our world works to a broader audience. A big thank you to Yale, OYC, and Stephen Stearns for this exquisite video course!

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One Response to “A Big Picture, Conceptual Introduction to Biology: EEB 122”

1. [Todd Walton](#) on 24 August 2011 at 3:13 pm



Wow! What a resource! Endless starting points for fascinating lines of inquiry, discussions, and imagining the future in new and hopeful ways. I will never complain again about there being nothing interesting to listen to on the radio. Thank you!

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- 2.