DOWNLOAD PDF THE EVOLUTION OF ADAPTIVE SYSTEMS

Chapter 1 : The evolution of adaptive systems (Book,) [www.nxgvision.com]

The Evolution of Adaptive Systems is the first to radically rework the theory of evolution. Rather than merely amplifying the original Darwinian evolutionary model, it encompasses it within a more dynamic concept - effectively merging the Darwinian theory with that other school of evolutionary thought, structuralism.

Overview[edit] The term complex adaptive systems, or complexity science , is often used to describe the loosely organized academic field that has grown up around the study of such systems. Complexity science is not a single theoryâ€"it encompasses more than one theoretical framework and is highly interdisciplinary, seeking the answers to some fundamental questions about living , adaptable, changeable systems. The study of CAS focuses on complex, emergent and macroscopic properties of the system. Holland said that CAS "are systems that have a large numbers of components, often called agents, that interact and adapt or learn. Human social group-based endeavors, such as political parties , communities , geopolitical organizations , war , and terrorist networks are also considered CAS. A MAS is defined as a system composed of multiple interacting agents; whereas in CAS, the agents as well as the system are adaptive and the system is self-similar. A CAS is a complex, self-similar collectivity of interacting, adaptive agents. Complex Adaptive Systems are characterized by a high degree of adaptive capacity , giving them resilience in the face of perturbation. Other important properties are adaptation or homeostasis , communication, cooperation, specialization, spatial and temporal organization, and reproduction. They can be found on all levels: Communication and cooperation take place on all levels, from the agent to the system level. The forces driving co-operation between agents in such a system, in some cases, can be analyzed with game theory. Characteristics[edit] Some of the most important characteristics of complex systems are: Moreover, the elements interact dynamically, and the interactions can be physical or involve the exchange of information Such interactions are rich, i. Such feedback can vary in quality. This is known as recurrency The overall behavior of the system of elements is not predicted by the behavior of the individual elements Such systems may be open and it may be difficult or impossible to define system boundaries Complex systems operate under far from equilibrium conditions. There has to be a constant flow of energy to maintain the organization of the system Complex systems have a history. Cohen [18] identify a series of key terms from a modeling perspective: CAS at the beginning of the processes are colored red. Changes in the number of systems are shown by the height of the bars, with each set of graphs moving up in a time series. Evolution of biological complexity Living organisms are complex adaptive systems. Although complexity is hard to quantify in biology, evolution has produced some remarkably complex organisms. As shown below, in this type of process the value of the most common amount of complexity would increase over time. Thus, the maximum level of complexity increases over time, but only as an indirect product of there being more organisms in total. This type of random process is also called a bounded random walk. In this hypothesis, the apparent trend towards more complex organisms is an illusion resulting from concentrating on the small number of large, very complex organisms that inhabit the right-hand tail of the complexity distribution and ignoring simpler and much more common organisms. If there is a lack of an overall trend towards complexity in biology, this would not preclude the existence of forces driving systems towards complexity in a subset of cases. These minor trends would be balanced by other evolutionary pressures that drive systems towards less complex states.

Chapter 2 : Origin and evolution of the adaptive immune system: genetic events and selective pressures

The Evolution of Adaptive Systems provides an interdisciplinary overview of the general theory of evolution from the standpoint of the dynamic behavior of natural adaptive systems. The approach leads to a radically new fusion of the diverse disciplines of evolutionary biology, serving to resolve the considerable degree of conflict existing.

A model represents and simplifies reality by showing relationships between the objects of a theory, causal interactions, and the states of a system Pickett et al. Models are useful abstractions of the dynamics of more-or-less complex systems and may be verbal, physical, graphical, or quantitative. Scientists and engineers often construct models to test hypotheses of how a process or a system functions, as there are limits to testing hypotheses on actual objects or structures. For example, the Corps of Engineers has long used physical models to test assumptions regarding river hydraulics, sediment transport, and environmental impacts of barge passage. Models are, however, are simplifications of reality and can rarely perfectly simulate real world conditions. The ecosystem models referred to in this report are mainly numerical models, in which elements and processes of a given ecosystem e. They offer scientists the opportunity to evaluate multiple ideas and hypotheses about disturbances, diseases, and other impacts on a given species or multiple species, but are not a substitute for empirical tests of hypotheses. Numerical models provide an opportunity to see how ecosystems might respond to a variety of human actions, and the better the model is able to simulate reality, the greater its credibility. Numerical models of ecosystems are useful for adaptive management applications and programs, as they allow scientists and stakeholders to observe how impacts vary across multiple management actions. The value of numerical models should be tempered with a clear understanding of model limitations and uncertainties in model projections, as the lack of communication or lack of common understanding between model builders and users may result in confusion and misinterpretation of model results. Mathematical models of the managed system are often developed to help understand systems behavior. But in poorly understood systems, or when the scale or risks of the actions being considered do not justify the expense of rigorous models, simple schematic diagrams can serve as useful conceptual models. Adaptive management recognizes the need for action in the face of uncertainty, and complete or perfect ecosystem models which are not likely to be perfected in any case do not need to be crafted in order to support decisions Walters, The National Academies Press. The focus should be on learning, not on getting ready to learn Lee, No matter what the setting or types of models used, it is important that adaptive management participants understand model assumptions and limits so that model results are not equated with reality. A range of management choices. Even when an objective is agreed upon, uncertainties about the ability of possible management actions to achieve that objective are common. For each decision, the range of possible management choices is considered at the outset in light of stated objectives and the model s of system dynamics. This evaluation takes into account the likelihood of achieving management objectives and the extent to which each alternative will generate new information or foreclose future choices. When possible, simultaneously implementing two or more carefully monitored actions can allow for rapid discrimination among competing models. Within the field of water resources planning and management, Gilbert White for decades strongly encouraged water managers and organizations to consider a broad range of alternatives for addressing water resources problems and opportunities White, Monitoring and evaluation of outcomes. Adaptive management requires some mechanism for comparing outcomes of management decisions. The gathering and evaluation of data allow for the testing of alternative hypotheses, and are central to improving knowledge of ecological, economic, and other systems. Monitoring should focus on significant and detectable indicators of progress toward management objectives. Monitoring should also help distinguish between natural perturbations and perturbations caused by management actions. Monitoring, in and of itself, however, does not ensure progress, and monitoring should not be equated with adaptive management. Monitoring programs and results should be designed to improve understanding of environmental and economic systems and models, to evaluate the outcomes of management decisions, and to provide a basis for better decision making ideally, independent estimates of the value of monitoring information and programs will be periodically conducted. Monitoring systems should be an integral part of program design at the outset and not simply added post hoc after implementation Holling, A mechanism s for incorporating learning into future decisions. Page 27 Share Cite Suggested Citation: Objectives, models, consideration of alternatives, and formal evaluation of outcomes all facilitate learning. But there should be one or more mechanisms for feeding information gained back into the management process. The political will to act upon that information must also exist. Without a mechanism to integrate knowledge gained in monitoring into management actions, and without a parallel commitment and the political will to act upon knowledge gained from monitoringâ€"which will not eliminate all uncertaintiesâ€"monitoring and learning will not result in better management decisions and policies. In addition, adaptive management organizations must likewise have some degree of flexibility in order to adjust operations in light of new information, environmental changes, and shifting social and economic conditions and preferences Gunderson, A collaborative structure for stakeholder participation and learning. The inclusion of parties affected by ecosystem management actions in decision making is becoming a broadly-accepted management tenet of natural resources management programs in the U. The Corps of Engineers, for example, has long supported this notion, and stakeholder outreach is a part of Corps planning studies in many locales. Achieving meaningful stakeholder involvement that includes give and take, active learning through cooperation with scientists , and some level of agreement among participants, represents a challenge, but is essential to adaptive management. This implies that some of the onus for adaptive management goes beyond managers, decisions makers, and scientists, and rests upon interest groups and even the general public. As mentioned, even though differences between stakeholders are inevitable, some agreement upon key questions and areas of research is essential to adaptive management of public projects Lee, Stakeholders may also need to exhibit flexibility and some willingness to compromise in order for adaptive management to be implemented effectively. In practice, developers first engage in a planning exercise in which they lay out a desired end state for the system the master plan, i. Within the context of rigidity that characterizes some traditional design practices, the view that designers should design and manage systems flexibly presents a challenge. But several concepts of flexible planning and engineering systems management have been developed that frame the planning process as a series of choices with indeterminate consequences de Neufville, Flexible Management of Engineering Systems Practices for the planning, design, and management of large, complex engineering systems are evolving in fundamental ways. Professional practice is in the middle of a transition that is reshaping design, evaluation, and implementation of major civil engineering developments. Individually, experts do not share a consensus on exactly how to describe this evolution. Collectively, however, traditional norms of practice are often viewed as insufficient in current settings and given current knowledge de Neufville and Odoni, Current and prospective Corps of Engineers practice should be sensitive to these changes. In broad terms, the evolution is from simplicity to complexity. Most major civil investments were traditionally designed and implemented primarily in terms of single investments, for single purposes, on the basis of a single forecast of future events, and with a narrow focus on construction Table 2. Page 29 Share Cite Suggested Citation:

DOWNLOAD PDF THE EVOLUTION OF ADAPTIVE SYSTEMS

Chapter 3 : Religion as an Adaptive System | Richard Sosis

The convergent evolution of these remarkably different adaptive immune systems involved innovative genetic modification of innate-immune-system components. Main Text Life began on our planet more than billion years ago, and evolving single-cell organisms, eubacteria, archaebacteria, and eukaryotes, have flourished ever since.

This project is aimed at uncovering the dynamics of the religious system. Religion may best be understood as an adaptive complex of traits incorporating cognitive, affective, behavioral, and developmental elements. These traits derive from pre-human ritual systems and were selected for in early hominin populations because they contributed to the ability of individuals to overcome ever present ecological challenges. By fostering cooperation and extending the communication and coordination of social relations across time and space, these traits served to maximize the potential resource base for early human populations, thereby benefiting individual fitness. The religious system is an exquisite complex adaptation that serves to support extensive human cooperation and coordination, and social life as we know it. Approaching Religion as a Complex Adaptive System. Multiscale Models of Complex Adaptive Systems, eds. In Human Simulation, ed. In Evolution, Cognition, and the History of Religion: A New Synthesis, eds. Sinding Jensen, and J. MacMillan Interdisciplinary Handbooks on Religion. The Brain, Cognition, and Culture, ed. An Evolutionary Perspective on Religious Terrorism. Philosophy, Theology, and Science 1: What evolutionary theories of religion tell us about religious commitment, in Challenges to Religion and Morality: Disagreements and Evolution, eds. Behavioral and Brain Sciences Criticaland Constructive Essays, eds. Israel Journal of Ecology and Evolution A Developmental Model, Eds. Proceedings of the British Academy Evolution and Religion, ed. Five Misunderstandings of the Adaptationist Program. Journal of Cognition and Culture 9: Eckart Voland and Wulf Schiefenhovel, pp. What makes a religion successful? Extrapolate back to Pius or the Council? A Darwinian Approach to a Dangerous World, eds. University of California Press.

Chapter 4 : Complex adaptive system - Wikipedia

Adaptive systems gravitate toward logistic and structural attractors, following dual pathways of dynamic equilibrium and evolution with respect to the structural element. Reciprocal adaptivity is commonly manifested in the biotic domain of an adaptive system.

History of evolutionary thought Adaptation is an observable fact of life accepted by philosophers and natural historians from ancient times, independently of their views on evolution , but their explanations differed. In natural theology , adaptation was interpreted as the work of a deity and as evidence for the existence of God. Pangloss [3] is a parody of this optimistic idea, and David Hume also argued against design. The series was lampooned by Robert Knox , who held quasi-evolutionary views, as the Bilgewater Treatises. Charles Darwin broke with the tradition by emphasising the flaws and limitations which occurred in the animal and plant worlds. This illustrates the real merit of Darwin and Alfred Russel Wallace , and secondary figures such as Henry Walter Bates , for putting forward a mechanism whose significance had only been glimpsed previously. A century later, experimental field studies and breeding experiments by people such as E. The Modern Synthesis [11] What adaptation is[edit] Adaptation is primarily a process rather than a physical form or part of a body. From this we see that adaptation is not just a matter of visible traits: Many aspects of an animal or plant can be correctly called adaptations, though there are always some features whose function remains in doubt. By using the term adaptation for the evolutionary process, and adaptive trait for the bodily part or function the product , one may distinguish the two different senses of the word. The other process is speciation , in which new species arise, typically through reproductive isolation. An organism must be viable at all stages of its development and at all stages of its evolution. This places constraints on the evolution of development, behaviour, and structure of organisms. The main constraint, over which there has been much debate, is the requirement that each genetic and phenotypic change during evolution should be relatively small, because developmental systems are so complex and interlinked. However, it is not clear what "relatively small" should mean, for example polyploidy in plants is a reasonably common large genetic change. Structural adaptations are physical features of an organism, such as shape, body covering, armament, and internal organization. Behavioural adaptations are inherited systems of behaviour, whether inherited in detail as instincts , or as a neuropsychological capacity for learning. Examples include searching for food , mating , and vocalizations. Physiological adaptations permit the organism to perform special functions such as making venom , secreting slime , and phototropism , but also involve more general functions such as growth and development , temperature regulation , ionic balance and other aspects of homeostasis. Adaptation affects all aspects of the life of an organism. The following definitions are given by the evolutionary biologist Theodosius Dobzhansky: Adaptation is the evolutionary process whereby an organism becomes better able to live in its habitat or habitats. Adaptedness is the state of being adapted: An adaptive trait is an aspect of the developmental pattern of the organism which enables or enhances the probability of that organism surviving and reproducing. Adaptation differs from flexibility, acclimatization , and learning. Flexibility deals with the relative capacity of an organism to maintain itself in different habitats: Acclimatization describes automatic physiological adjustments during life; [30] learning means improvement in behavioral performance during life. Flexibility stems from phenotypic plasticity , the ability of an organism with a given genotype to change its phenotype in response to changes in its habitat , or to move to a different habitat. A highly specialized animal or plant lives only in a well-defined habitat, eats a specific type of food, and cannot survive if its needs are not met. Many herbivores are like this; extreme examples are koalas which depend on Eucalyptus , and giant pandas which require bamboo. A generalist, on the other hand, eats a range of food, and can survive in many different conditions. Examples are humans, rats , crabs and many carnivores. The tendency to behave in a specialized or exploratory manner is inheritedâ€”it is an adaptation. Rather different is developmental flexibility: The ability to acclimatize is an adaptation, but the acclimatization itself is not. Fecundity goes down, but deaths from some tropical diseases also go down. Over a longer period of time, some people are better able to reproduce at high altitudes than others. They contribute more heavily to later generations, and gradually by natural selection the whole population becomes adapted to the new conditions. This has demonstrably occurred, as the observed performance of long-term communities at higher altitude is significantly better than the performance of new arrivals, even when the new arrivals have had time to acclimatize. Fitness biology and Fitness landscape There is a relationship between adaptedness and the concept of fitness used in population genetics. Differences in fitness between genotypes predict the rate of evolution by natural selection. Natural selection changes the relative frequencies of alternative phenotypes, insofar as they are heritable. Dobzhansky mentioned the example of the Californian redwood , which is highly adapted, but a relict species in danger of extinction. The average contribution to the next generation by a genotype or a class of genotypes, relative to the contributions of other genotypes in the population. The absolute contribution to the next generation by a genotype or a class of genotypes. Also known as the Malthusian parameter when applied to the population as a whole. The extent to which a phenotype fits its local ecological niche. Researchers can sometimes test this through a reciprocal transplant. To evolve to another, higher peak, a population would first have to pass through a valley of maladaptive intermediate stages, and might be "trapped" on a peak that is not optimally adapted. A large population is needed to carry sufficient diversity. According to the misrepair-accumulation aging theory, [42] [43] The misrepair mechanism is important in maintaining a sufficient number of individuals in a species. Without misrepairs, no individual could survive to reproduction age. Thus misrepair mechanism is an essential mechanism for the survival of a species and for maintaining the number of individuals. Although individuals die from aging, genome DNAs are being recopied and transmitted by individuals generation by generation. Adaptation is the heart and soul of evolution. The Great Debate at the High Table of Evolutionary Theory [45] Changes in habitat[edit] Before Darwin, adaptation was seen as a fixed relationship between an organism and its habitat. It was not appreciated that as the climate changed, so did the habitat; and as the habitat changed, so did the biota. Also, habitats are subject to changes in their biota: The relative numbers of species in a given habitat are always changing. Change is the rule, though much depends on the speed and degree of the change. When the habitat changes, three main things may happen to a resident population: In fact, all three things may occur in sequence. Of these three effects only genetic change brings about adaptation. When a habitat changes, the resident population typically moves to more suitable places; this is the typical response of flying insects or oceanic organisms, which have wide though not unlimited opportunity for movement. It is one explanation put forward for the periods of apparent stasis in the fossil record the punctuated equilibrium theory. By this means, the population adapts genetically to its circumstances. Habitats and biota do frequently change. Therefore, it follows that the process of adaptation is never finally complete. On the other hand, it may happen that changes in the environment occur relatively rapidly, and then the species becomes less and less well adapted. Seen like this, adaptation is a genetic tracking process, which goes on all the time to some extent, but especially when the population cannot or does not move to another, less hostile area. Given enough genetic change, as well as specific demographic conditions, an adaptation may be enough to bring a population back from the brink of extinction in a process called evolutionary rescue. It should be noted that adaptation does affect, to some extent, every species in a particular ecosystem. This became known as the Red Queen hypothesis , as seen in host- parasite interaction. Co-adaptation Pollinating insects are co-adapted with flowering plants. These co-adaptational relationships are intrinsically dynamic, and may continue on a trajectory for millions of years, as has occurred in the relationship between flowering plants and pollinating insects. Mimicry A and B show real wasps ; the rest are Batesian mimics: A common example seen in temperate gardens is the hoverfly , many of whichâ€"though bearing no stingâ€"mimic the warning coloration of hymenoptera wasps and bees. Such mimicry does not need to be perfect to improve the survival of the palatable species. Adaptations serving different functions may be mutually destructive. Compromise and makeshift occur widely, not perfection. Selection pressures pull in different directions, and the adaptation that results is some kind of compromise. Diversity, Evolution, and Inheritance [62] Consider the antlers of the Irish elk , often supposed to be far too large; in deer antler size has an allometric relationship to body size. Obviously, antlers serve positively for defence against predators , and to score victories in the annual rut. But they are costly in terms of resource. Their size during the last glacial period presumably depended on the relative gain and loss of reproductive capacity in the population of elks during that time. Here the risk to life is counterbalanced by the necessity for reproduction. Elongated body protects their larvae from being washed out by current. However, elongated body increases risk of desiccation and decreases dispersal ability of the salamanders; it also negatively affects their fecundity. As a result, fire salamander , less perfectly adapted to the mountain brook habitats, is in general more successful, have a higher fecundity and broader geographic range. It must reduce his maneuverability and flight, and is hugely conspicuous; also, its growth costs food resources. The most vital things in human life locomotion, speech just have to wait while the brain grows and matures. That is the result of the birth compromise. Much of the problem comes from our upright bipedal stance, without which our pelvis could be shaped more suitably for birth. Neanderthals had a similar problem. However, as previously stated, there is always a trade-off. This long neck is heavy and it adds to the body mass of a giraffe, so the giraffe needs an abundance of nutrition to provide for this costly adaptation. For example, the polyploid cordgrass Spartina townsendii is better adapted than either of its parent species to their own habitat of saline marsh and mud-flats. Exaptation Features that now appear as adaptations sometimes arose by co-option of existing traits, evolved for some other purpose.

Chapter 5 : Adaptive system - Wikipedia

Well before the evolution of an adaptive immune system, however, innate mechanisms of self-defense were acquired. Even single-cell organisms have heritable defense mechanisms, and every multicellular organism appears to have a complex innate immune system (Beutler,).

Adaptive An adaptive system or a complex adaptive system, CAS is a system that changes its behavior in response to its environment. The adaptive change that occurs is often relevant to achieving a goal or objective. We tend to associate adaptive behavior with individual plants, animals human beings, or social groups. However, relatively simple systems can also be adaptive. Because a CAS adapts to its environment, the effect of environmental change cannot be understood just by considering its direct impact. We must also consider the indirect effects due to the adaptive response. Recognizing the way that indirect effects arise from adaptation can help us understand how to influence complex systems in a desired way. An example of adaptation is the growth of a plant around obstacles. Without obstacles a plant will grow according to a kind of pattern. The growth of a plant will change if there are obstacles, and the specific change that occurs depends on the arrangement of obstacles. We say that the plant adapted to its environment. Another type of adaptive behavior, learning, is more typically associated with animals. More generally, learning occurs when a pattern of behavior of the system changes as a result of an interaction with the environment. This involves two levels of response by the system: The system responds in a way that changes its future response. To understand this, it is helpful to distinguish between more variable and more persistent aspects of the system. When an adaptive system responds to a change in its environment, part of the response is a change in the more persistent aspects of the system. These changes can affect the system response at a later time. We often think of the more variable aspects of a system as the external ones and more persistent aspects as internal. The two level concept of adaptation implies learning is "internalizing"retaining information about the environment in a form that can influence the behavior of the system. Retaining information is helpful for goal directed behaviors if the environment repeats patterns of behavior. Goal seeking adaptation We generally associate adaptation with goal seeking behavior. A goal seeking system "tries" to adapt changes its behavior in order to achieve its goal. It is helpful to notice, that goal seeking behavior can be readily realized in systems that have feedback. A thermostat coupled to a furnace has goal seeking behavior. It can also be said to be adaptive, because changes in the environment or in the system itself changes in the outside temperature, opening the windows, changes in the furnace efficiency change its behavior. The change is a difference in the on- time and off-time of the thermostat which achieves the goal of the system, which is a temperature within a desirable range. Physical systems, like fluid flowing downward in gravity, also display characteristics of goal seeking behavior. Water flows around and even over small enough obstacles. The goal seeking behavior of water includes feedback because of the collective interactions of water molecules and surface tension. Equilibrium chemical systems composed of reactive substances also adapt to changes in a well understood way. If we add one of the reactants, some of the added chemical will react to reduce the change in concentraion of the added chemicalthe chemical process reduces the change that was imposed. One of the greatest scientific controversies in recent times was caused by the suggestion that the biosphere is an adaptive system that responds to changes. It is helpful to note that the basic adaptive response associated with Gaia is no more than what is displayed by a chemical reaction. Evolution as adaptation A collection of organisms can also respond to environmental change. Evolution is the adaptive response of a group of organisms that occurs over many generations. Evolutionary changes reflect the response of the collection of organisms to their environment. This involves both internal changes e. Since goal directed behaviors are generally associated with adaptation, the concept of the will to survive in animals plays an important role in conceptual aspects of evolutionary theory. This is, however, somewhat confusing as the goal is attributed to individual organisms, while in evolution the collection of organisms not the individual is adapting.

Chapter 6 : Evolution of the immune system in humans from infancy to old age

"The Evolution of Adaptive Systems, rather than merely amplifying the original Darwinian evolutionary model, encompasses it within a more dynamic concept - effectively merging the Darwinian theory with that other school of evolutionary thought, structuralism.

References Abstract Historically, two components of immunity were identified, innate and adaptive. Innate receptors recognise molecular patterns common for groups of pathogens or for common pathological changes in host cells. All animals are protected by innate immunity. The repertoire of adaptive immune receptors in each individual differs in dependence on its life history and provides a basis for a strong memory response. However, they are strikingly similar functionally pointing to similar evolutionary forces shaping these systems. Both adaptive and innate strategies are used in organisms from bacteria to humans. Innate mechanisms provide basic protection based on evolutionary conserved features of pathogens whereas adaptive mechanisms provide immunity that is shaped by the life history of every individual. Adaptive immunity of jaw and jawless vertebrates is based on different receptors but functionally similar pointing to the same evolutionary driving forces. Combination of adaptive and innate mechanisms is necessary to provide the most comprehensive immune protection. Genome duplications played a crucial role in the origin of the adaptive immune system. Adaptive immune system coevolve with innate immune mechanisms. The organisation of a hypothetical mammalian immunoglobulin heavy chain locus is shown. At the first step, one of the D segments rearranges to one of J segments. Next, one of V segments rearranges to DJ. All intervening sequences are excised. After antigen exposure, any of the downstream constant regions can replace Cmu through class switch recombination. VLR receptors are encoded as an empty cassette containing only flanking gene segments. Alongside it, hundreds of LRR modules are encoded in different orientations. They are brought into the cassette in stepwise fashion by gene conversion, which presumably is mediated by the enzymes of cytosine deaminase family. Two whole genome duplication events are thought to play a vital role in the evolution of vertebrate adaptive immunity. The most accepted view is that the first duplication took place before splitting of vertebrate lineages whereas the second took place in jaw lineage. However it may be that both duplications happened before the split. Genes similar to components of TCR and BCR are present in lamprey whereas genes similar to VLR are found in zebrafish suggesting that elements of both systems were present in the vertebrate ancestors. International Reviews of Immunology 31 5: Cyster JG B cell follicles and antigen encounters of the third kind. Nature Immunology 11 Annals of the New York Academy of Sciences Nature Immunology 9 7: Trends Immunology 33 8: Current Opinion in Gastroenterology 28 6: Nature Reviews Genetics 11 1: Seminars in Immunology 22 1: Developmental and Comparative Immunology 35 9: Hedrick SM The acquired immune system: PLoS One 7 9: International Immunology 8 6: Janeway CA Immunobiology: PLoS Biology 3 6: Clinical and Experimental Medicine 9 4: Kasahara M The 2R hypothesis: Current Opinions in Immunology 19 5: Journal of Immunology 8: Journal of Theoretical Biology 2: Kuraku S Palaeophylogenomics of the vertebrate ancestor â€" impact of hidden paralogy on hagfish and lamprey gene phylogeny. Integrative and Comparative Biology 50 1: Lee YK and Mazmanian SK Has the microbiota played a critical role in the evolution of the adaptive immune system? PLoS Biology 6 6: Matsunaga T and Rahman A What brought the adaptive immune system to vertebrates? Journal of Immunology Cell Host and Microbe 9 5: Annual Reviews of Immunology BMC Immunology 10 8: Biological Bulletin 3: Nature Immunology 8 6: Nature Reviews Immunology 11 4: Immunological Reviews 1: Storb U and Stavnezer J Immunoglobulin genes: Current Biology 12 Tonegawa S Somatic generation of antibody diversity. Nature Reviews Immunology 12 7: Annual Review of Immunology Hsu E The invention of lymphocytes. Current Opinion in Immunology 23 2: Nature Reviews Immunology 10 8: Journal of Immunology 6: Paul WE Fundamental Immunology.

Chapter 7 : Adaptation - Wikipedia

The survival advantage gained through adding this type of adaptive immune system to a pre-existing innate immune system led to the evolution of alternative ways for lymphocytes to generate diverse antigen receptors for use in recognizing and repelling pathogen invaders.

Chapter 8 : The evolution of adaptive systems (eBook,) [www.nxgvision.com]

The adaptive immune system (AIS) is fascinating to both scientists and laymen: we have a specific yet incredibly diverse system that can fight myriad pathogens and has a 'memory' â€” the basis of vaccination â€” that enables a rapid response to previously encountered pathogens.

Chapter 9 : The evolution of adaptive immunity. | GreenMedInfo

Purzycki, Benjamin and Richard Sosis The Religious System as Adaptive: Cognitive Flexibility, Public Displays, and Acceptance, in The Biological Evolution of Religious Mind and Behavior, eds. Eckart Voland and Wulf Schiefenhovel, pp. , New York: Springer-Verlag Publishers.