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Questions of Science, Answers to Life

漫游科学天地 解读生命奥秘

—— 当代自然科学和社会科学入门


Oscar De Los Santos, Ph.D.
and
John-James Sargent, M.A.



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序

中国在新世纪里的腾飞需要数以千万计乃至更多具有现代意识的高尖人才。这类新型人才在自己的专业领域里会有所建树，其专业的精深是构建在博大宽厚的知识基础和框架上的。因而，他们不仅在本专业领域里耕耘拓展，而且以极大的热忱和敏锐关怀着有关人类世界及天地间所有根本性的问题，文学、历史、艺术、哲学、自然科学和社会科学，一切都在其视野和思索之内，而对于宏观世界的关怀和感悟，则为其在专业内的发展提供了无限的灵感和发力。新世纪的中国呼唤数以千万计的“文艺复兴式”的人才，新世纪的中国为这种博大精深的人才的问世提供了得天独厚的条件。

如果你有心成为这样的人才，就请打开《漫游科学天地，解读生命奥秘》这本难得的好书吧。它会引导你漫游当今自然科学和社会科学的几乎所有重要的领域，巡视太空与地球，洞察 DNA 克隆；它不仅向你提供包括宇宙的起源、恐龙的消亡、生命的奥秘、环境与人类、大脑与记忆、遗传工程、人工智能，甚至最新的生物恐怖战争等的最基本的知识以及五光十色的理论与假说，而且激发你对有关人类自身及生存环境等最根本问题的关注和思考。

如随后所附的作者小传所示，两位作者不仅自然和社会科学知识厚实，而且对科幻小说这个文学与科学融合的领域的研究很有建树，创作颇丰，发表甚多。《漫游科学天地，解读生命奥秘》得力于两位作者的厚实功底和才华，以全、新、扎实、准确、走笔从容、可读性强、易读易懂的特点与读者见面。其丰富的脚注、词汇表、索引、文献等不仅有助于阅读，而且为愿意深入研读探讨的读者提供了去处。

不管你的专业是文学艺术、历史哲学、工商管理，还是地球物理、生物化学、电脑工程，只要你受过良好的教育，只要你具备一定的英语阅读能力，只要你对人及其“生与斯，养与斯”的宇宙环境抱有孩童与哲人般的好奇，都可以从这本书里获得有益的养分。即使你已经大致熟悉当代科学发展的脉络，它也会帮助和激发你用英语去思考、关怀和感悟那些有关人类自身和生存环境的带根本性的问题。

一本科普读物不能使你成长为“文艺复兴式”的人才，但它可以为你提供养分，提供生长的激素。日复一日，一本接一本，亦读亦思，累积起来，必有成效。

既学英语、又掌握科学知识；学科学、兼而提高英语水准。一份耕耘，两份收获，何乐而不为？

就从这本书开始吧。

祁寿华

2003 年秋于美国康州

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*With gratitude and respect, we dedicate this book to
Carl Sagan
Teacher, Thinker, Dreamer*

Introduction

Welcome to *Questions of Science, Answers to Life*. This book will familiarize you with a wide variety of subjects related to the world of science, past and present. Some of the chapters focus on pressing global matters. Others offer information on subjects that have long intrigued humankind. All of the book's sections include the very latest information on their given subjects. Moreover, our discussion of these subjects is easily accessible to those with little or no background on the topics. We believe that our book is a useful primer for the person interested in gaining a general knowledge about a number of significant subjects related to the earth, life, social and space sciences.

The world is ancient, although not as old as countless other planets and stars in the cosmos. Our book provides a glimpse of our own universe as well as other wondrous phenomena in the far reaches of space. It invites speculation. Are we alone in the heavens or do other forms of life exist? If so, where might we look for such distant kin? How are we looking? What or whom might we find? *Questions of Science, Answers to Life* launches the reader into the world of black holes, wormholes and other strange wonders found in the distant realms of space.

Although we set our gaze on outer space from time to time, the dominant focus of our book is rooted on Planet Earth. Our chapter on dinosaurs and extinction theory reminds us of the ancient age of our world. Chapters on nuclear waste and bioterrorism make us ponder over humanity's great potential for creative ingenuity — and reckless self-destruction. A section on cloning makes us probe the potential benefits of such experiments, as well as the sober ethical and moral dilemmas raised by cloning research.

Today's global society stands collectively at a crossroads. One direction leads toward life, the other toward death. In order to embrace the former, we must take measures to eradicate certain practices that threaten our extinction. Some of the chapters in this text may frighten the reader. They are not intended to do so. Instead, they are designed to assist our audience in fully recognizing some of the most challenging problems that humanity faces. Wherever possible, we have included discussions of solutions to these prob-

lems as they have been addressed and posited by concerned citizens the world over.

Most especially, *Questions of Science, Answers to Life* hopes to inform the general reader about a host of subjects that have fueled human curiosity in the past, intrigue us in the present and will no doubt continue to interest us in the future. Join us for what we hope is an enjoyable, informative and thought-provoking read!

Oscar De Los Santos and John-James Sargent

November 2003

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PART I — LIFE SCIENCES

THE HUMAN BRAIN AND MEMORY

The Human Database

The human body can easily be categorized as one of the most complex and efficient machines in existence. Among its most sophisticated components is the brain. Scientists and philosophers, theologians^① and artists debate the connections between mind, body and spirit, but many in the scientific camps believe without question that it is our brains that are responsible for imagining — and thereby giving birth to — such concepts as the human spirit. Many scientists today emphasize the emerging connections between seemingly untraceable^② and ephemeral^③ emotions and subtle biological processes that the body experiences as it moves from one mood or feeling to the next. Life is all-biological, they claim, and the main reason we feel or think or experience anything at all — indeed, the reason we are capable of living — is due to the brain. Today, the brain remains one of the most mysterious organs in the human body. And yet, in recent years, scientists have made substantial inroads^④ into understanding the workings of the human brain and its connections to consciousness and the human body.

One of the greatest assets of the human brain is its capacity to harbor human identity and memory. A memory is a record of a part of our lives, be it an event, a person, a task. Indeed, it is not erroneous to say that we are comprised of memories — that memories are our lives. Like a complex computer with a storehouse of information ready to be accessed with a click of a computer's mouse, the brain is a living database that we can access, both consciously and unconsciously. The brain reminds us who we are, helps us func-

① theologian 神学家

② untraceable 难以查出的, 难以描绘的

③ ephemeral 极短的, 短暂的

④ inroad 进展

tion in our daily lives, and helps us reflect on our past.

Systems of Memory

The brain's capacity to storehouse memories is of immeasurable value and a vital component of human existence. At the core of neuroscience^①, those in the field have determined that there are two principal systems of memory: *explicit memory*^② and *implicit memory*^③. *Explicit memory* is comprised of information that we consciously retrieve from our living database: the names of our friends, our pets, the model of our car, our home address, and so forth. *Implicit memory*, on the other hand, is comprised of information that we obviously keep stored and call to use without consciously doing so. For example, we do not have to keep reminding ourselves to put one leg in front of the other when we go for a walk. Nor do we consciously tell ourselves to extend one leg in front of the other in extremely rapid fashion when we wish to go for a run. The body remembers that this is what needs to be done in order to walk or run. In similar fashion, we might be engaged in a lively conversation while driving a friend to the office. In doing so, we are not constantly telling our body to hit the car's brakes, flick its turn signal switch or check the rearview mirror^④ when we are changing lanes. Again, these are activities that we have previously learned that are necessary in order to drive a vehicle. We complete these tasks without devoting a great deal of conscious thought to them.

How does the human mind distinguish between one bit of information it is exposed to and another? How does it know to categorize some information as explicit and some as implicit? It seems that each of us is responsible for doing just that, depending on the manner in which we spend our daily lives and the type of activities in which we engage. To distinguish further between the kinds of information that we "feed" our brain, researchers often speak of

① neuroscience 神经系统科学

② explicit memory 外显记忆

③ implicit memory 内隐记忆

④ rearview mirror 后视镜

procedural memory^① and *declarative memory*^②. For better or worse, life is full of rules and regulations, and as we study these rules and regulations, we commit the information to memory. More specifically, as we all know, there are various right and wrong ways to execute most tasks. If the task is something we engage in frequently, we will often experiment with procedure and then find the way that best suits us to accomplish the task. Thus, repetition helps us learn and retain the knowledge necessary to execute the task. This information is part of our *procedural memory*. To return to our car-driving analogy, we know that there is a certain order of steps that must be executed in order to drive the vehicle. We unlock the door, get inside, slip the key into the ignition, etc. This is all part of the learned procedure that we store in our brain after practice and repetition. *Declarative memory*, on the other hand, has nothing to do with remembering a specific set of rules or procedures in order to accomplish a task. We remember our address to find our way home. We remember where we work in order to make a living. We remember where our favorite items are placed in the grocery store so that we can get in and out of the store as quickly as possible. To sum up, procedural memory involves the use of unconscious information that we use to execute tasks, while declarative memory involves conscious memorization of information.

Just as there are two distinct systems of memory, there are two basic types of memory. Different scientists give these systems different names but perhaps the two most common distinctions are *short-term memory*^③ and *long-term memory*^④. Short-term memory helps us remember information that we need to use immediately. Perhaps we need a phone number out of a book, or the name of a person that we are dealing with during a business call for a very short time, or the title of a book we are retrieving for a friend at the library. This is information that we need in order to accomplish the task, however, we do not need it in our head for longer than a brief period of time. The human brain is sophisticated enough to make that distinction, harbor the information for a brief period so that we can use it, and then dispose of it. Afterward, this material is discarded from our living database. Long-term memo-

① procedural memory 程序性记忆

② declarative memory 陈述性记忆

③ short-term memory 短时记忆

④ long-term memory 长时记忆

ry. on the other hand, is far more complex. Typically, long-term memory focuses on experiences that meant a great deal to us, on individuals that influenced us significantly, and unfortunately, on events or individuals which caused us harm and greatly disturbed us.

Long-term memories are awarded more permanent residence in our minds by our review of the event(s) or individual(s) or information in question. Like re-reading a favorite book or screening a film over and over, we re-run all aspects of this event or information through our heads. In so doing, the memory becomes etched^① into our psyche^② and virtually impossible to erase. Indeed, some people argue that it isn't really unfortunate that we remember certain events or people that caused us harm or turmoil. By doing so, some experts argue, there is less of a risk of repeating the event or reacquainting ourselves with the individual who brought us grief.

Uploading the Memory File

Computers store memory throughout a designated portion of a hard-drive. However, when that particular file (be it an image or text document) is not in use, the information that comprises that file may be scattered throughout the system. It is only when we upload a file that the information is retrieved, organized and becomes that particular document or image. The human brain stores memories in much the same way. Although the hippocampus^③ is usually touted as^④ being the part of the brain that processes memories, the elements that make up the memory itself are believed to be stored throughout the outer large and bumpy^⑤ part of the brain known as the cerebral cortex^⑥. When we remember a particular person, we recall his name, his features, the types of clothes he tends to favor, and his scent. If we happen to know this person

① etch 铭刻, 深印

② psyche 心灵, 自我

③ hippocampus 海马(每一个侧脑室下角底的一条海马状突起)

④ tout ... as 把……说成是

⑤ bumpy 高低不平的

⑥ cerebral cortex 大脑皮层

well, our mental picture of him is extremely vivid. In order to create that image in our head, however, the mind has brought together a number of memories or characteristics that we attribute to that person. Each of these characteristics is important to our mental picture of that particular person, but interestingly, each of these characteristics is likely stored in a different part of the brain.

Scientists have learned that different parts of the brain register and remember different aspects of an event or an individual. Such is the reason that more scientists are stressing the biology at the heart of the workings of the human mind. In some ways, they are demystifying^① the complex organ we often think of as mysterious and almost superhuman in its capabilities and scope. Make no mistake; the brain is still a fascinating and largely mysterious component of the human body. However, those who explore it are making inroads toward explaining its processes, most of which until recently were great conundrums^②. In the past, the brain was thought to possess uncanny^③ abilities bordering on the supernatural^④, especially when it comes to its powers of memory and retention. Today, on the other hand, many researchers emphasize that there are chemical reactions and processes that the mind undergoes in order to imprint^⑤ certain concepts and images into our psyche, store them, and dredge^⑥ them up.

The Biology of Memory and Emotion

Current research is doing much to demystify the brain in one respect, even as it reveals just how complex the organ is and how much more we have to learn before we can claim we fully understand it. Recent interpretations of the process of the human mind stress that biological operations are constantly tak-

① demystify 使……非神秘化,启发

② conundrum 谜,难题

③ uncanny 超人的

④ supernatural 超自然的,神秘的

⑤ imprint 盖(印),铭刻

⑥ dredge 疏浚,挖掘