Darwin’s Tea Party
Evolution, Genetics and Human Nature

prepared for Humanities 345-101-MQ “Darwin’s Tea Party”
Dawson College College Fall 2016

by

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1. INTRODUCTION

1.1 About Darwin’s “Dangerous Idea”

Sections 1.1-1.5 provide an introduction to and overview of the course, including key terms like “biological knowledge”, the geological, cultural evolution and historical timescales; an overview of the course listing key events, places, people and ideas we will explore throughout the semester and list of key skills course aims to develop.

This course is named after Charles Darwin (1809-1888), a British naturalist and the founder of the theory of evolution by natural selection, one of the most important and controversial ideas ever published. Darwin’s evolution theory has been called a “dangerous idea” by many authors, including some who agree with it and for many different reasons. Perhaps you already know that Darwin’s evolutionary theory claims that human beings evolved from apes. This idea clashed with certain religious views and some feared that Darwin’s theory was immoral and would threaten beliefs that were essential to society. This is one reason Darwin’s theory has been called “Dangerous” – it challenged religious beliefs that had guided society for a long time.

But evolution has had a powerful impact not just on religion but on other ideas too. For example, many of us believe that human society has “evolved” from “primitive” beginnings to the “advanced” scientific and technological culture we have now. Looking at our technological society of computers and cell phones and it seems obvious that we have come a long way from our “primitive” ancestors. The idea that society has also evolved is another way in which Darwin’s theory has influenced our thinking. It seemed to “prove” that human society had also evolved. But what about other societies that don’t have the technology we have? What about those societies that don’t have the beliefs or ideas of our own society – like faith in science, technology, economic competition, etc…? Are they less “evolved” than our own society? Some people thought so and they used the idea of evolution to justify the domination and even extermination of what they thought were “less evolved” or “primitive” people. Even today, some writers use evolutionary ideas to claim that some groups of people aren’t as able or as intellectually gifted as others because they haven’t “evolved” as much or are not “fit”. This is yet

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another reason why Darwin’s evolution idea has been called “dangerous”: it can be and has been used to oppress others.

Can ideas be dangerous? Whether or not Darwin intended it, it seems all too easy to use his evolution theory to support even the most immoral or unethical acts. In the wrong hands, it seems, even the most scientific ideas can be twisted to serve the most destructive of purposes. This was the case for Darwin’s ideas of evolution, natural selection and “survival of the fittest”. Ideas, in short, can indeed be dangerous, whether those ideas are scientific, religious, political or economic.

But ideas can also be truly amazing and inspiring and this includes the idea of evolution itself and many other ideas we consciously or unconsciously follow in our daily lives. For example, evolution implies that all human beings are related because we evolved from a common ancestor. It also means humans are “related” to other creatures because all creatures are descended from other, previous ancestors. Some have taken this to mean that we are all “family” and connected together like a huge network in the web of life with one part dependent on the other. Damage to one part of the web will affect another part and we are not just isolated individuals like separate islands disconnected to each other. As the poet John Donne put it

_No man is an island, entire of itself...any man's death diminishes me, because I am involved in mankind._

If this is what evolution teaches, it would seem we ought to show greater care and compassion for each other and for other life forms. But this is indeed a far cry from how many would interpret “the survival of the fittest”! Today, some people credit Darwin’s theory and evolution for making us more aware of our connection to other creatures and our connection to the environment, one of the most important issues of our time. One can see that whether ideas are dangerous or beneficial depends on how we interpret the work of influential writers like Darwin. But not every interpretation is equally valid. It is one goal of this course to provide a more accurate interpretation and understanding of Darwin’s theory than is often presented.

As shown below ideas like evolution are a key part of knowledge, whether of ourselves or of our environment. Learning about such ideas is also crucial to our personal development and identity since we also look at the world and ourselves through the ideas we have received from parents, society, peers, media, teachers and other authorities. Becoming conscious about the ideas we carry around with us, enables us to decide for ourselves which of these to accept and which to reject or modify. Thus we need to study ideas carefully so that we can learn to recognize their dangers and use them to benefit rather than to harm humanity and ourselves. This is essential to becoming an educated, conscious and contributing member of society. Learning about ideas, in short, helps us to grow as people and to answer the basic questions many humanities courses address: Who are we? Where have we come from? Where are we going? What does it mean to be a human being? What is the best way to live?

The next section provides a more specific understanding of the kinds of ideas we look at in this text and in this course, including its main goals. As you will see, Darwin’s theory is only one part of what we examine here.
1.1 Overview of the Course

This book examines the development of biological knowledge with special emphasis on Darwin’s evolutionary theory, its origins, basic elements, and its impact on our history and our lives today. But we will also look before and beyond Darwin to knowledge in general and scientific knowledge in particular and how science became the dominant form of knowledge in the modern period. This will prepare us to better understand the main theme of this course: biological knowledge, its origins, growth, use, misuse and impact on human life, thought, society and the environment from the earliest period to the present time. The course thus adopts a historical approach beginning “at the beginning” (prehistoric biological knowledge) and moving toward the present (contemporary biological knowledge). It tries to develop a continuing story or narrative – the story of humanity’s quest for knowledge about life and how this quest has transformed that very life itself. How the book and the course are divided is briefly explained below.

Chapter 2 is a long chapter that covers a very long time scale in human history but it is necessary to provide some of the key background facts and ideas we need to better understand the development of science and religion in our culture, Darwin’s theory, as well as to provide a glimpse of the importance and impact of biological knowledge before the modern period. The chapter also provides some of the basic ideas, facts and events necessary to begin to understand the origin, development and meaning of culture, society, civilization and western civilization in particular. We begin by examining the development of biological knowledge from the very beginning of human life in the prehistoric period (section 2.1 on “Prehistoric Biological Knowledge”). This section shows that certain kinds of biological knowledge – possessed by the small nomadic hunting-gathering and scavenging cultures – were absolutely essential to the earliest humans and remain so to the few peoples who still make their living in these traditional
ways. Note that this chapter does not trace the evolution of humanity from its ape-like ancestors but examines humans who are already humans in the same sense that we are, except that they lived in different time periods and cultures.

In section 2.2 of the same background chapter, we examine the invention or discovery of agriculture and animal husbandry; perhaps the most important of all applications of biological knowledge since it triggered the change from small, nomadic cultures to large, complex and sedentary, urban civilization. The origin of civilization and its connection to agriculture in the Ancient Middle East is emphasized. Next, some of the biological knowledge of the ancient civilizations and especially the contribution of the ancient Greeks are examined, especially in relation to the birth of philosophy, the origin of western science and to the beginnings of a scientific form of biological knowledge.

The impact of religion, most specifically, the Judeo-Christian-Islamic tradition on our ideas about human beings and human nature, are also examined in this chapter, in the context of “Medieval Biological Knowledge”. Some of the key events in the modern period will then be described, including the 17th and 18th century Scientific Revolution that paved the way for Darwin later in the 19th century.

Chapter 3 finally explains Darwin’s theory of evolution by natural selection, the most important concept in the course. A thorough understanding of this idea is necessary to understanding the subsequent chapters. Chapter 4 looks at the impact of evolution on religion, especially on Christianity. We examine a variety of reactions to Darwin’s theory, including its rejection by fundamentalist churches in the USA and accommodations to it by other Christian churches. Chapter 5 provides some examples of how evolutionary theory was used and misused to justify various political ideologies that promoted “struggle for survival” and “survival of the fittest” as the best ideas by which to organize human society. These ideologies, called social Darwinism, are now seen as dangerous misapplications or distortions of Darwin’s theory but they are a useful warning to us about how easily some ideas can be put to destructive purposes. Chapter 6 investigates the development of genetics, which has always been intimately tied to evolutionary theory. Eugenics, another example of a social or political movement influenced by Darwin’s biological theory, is examined in Chapter 7. This ideology promoted a supposed “improvement of the human race” through selective breeding of humans. Ideas like eugenics and social Darwinism were often categorized as belonging to the “nature” side of the “nature vs. nurture debate”. This chapter ends by examining the role that social Darwinism and eugenics played in the ideological background to World War II, and especially to Nazi ideology and to the mass killing known as the Holocaust. The war provides a crucial turning point in the course, exemplifying the destructive consequences of some of the social Darwinist ideologies examined earlier.

Chapter 8 brings us into the post-war world and introduces us to the “nature-nurture” debate, showing how and why “the nurture assumption” triumphed over “the nature assumption” in this period. A connection is made between the triumph of the nurture assumption and the struggle for social, racial and economic equality in the post-war period. Chapter 9 returns to an examination of scientific developments in the present day by looking into what has been called the biological revolution. This chapter opens up for study the Pandora’s box of genetic
engineering, cloning, gene therapy that biological knowledge and technology are presently developing. We examine the claims that the Biological Revolution encouraged a return to biological ideas about human nature in our own time. **Chapter 10** focuses on the resurgence of biological explanations of human nature, including the new disciplines of sociobiology, evolutionary psychology and behaviour genetics. These are all recent attempts to try and unearth the alleged biological roots of human nature, behaviour and mental ability, using the Darwinian framework of evolution by natural selection. Whether these represent a shift back into the direction of “nature” explanations of human nature and the consequences of such a shift are raised. The aim here is to encourage students to think critically about the role that science and scientific knowledge should play in our understanding of what human beings are and in what kind of society we should have. **Chapter 11** is left blank so students can answer these questions themselves.

### 1.3. Goals of the Course

There are many different ways of understanding and assessing the nature, development and impact of biological knowledge. This book seeks to introduce students to some of these approaches, provide them with a basic historical framework for understanding them and presents key concepts that will familiarize students with the basic terminology. But **this is not a biology or a science course**. Instead, we examine biological knowledge and biological science as human activities that have had and continue to have tremendous importance on human society and human beings to this day. We are not just interested in learning about Darwin’s theory but about the impact Darwin’s theory (and much more besides) has had on our lives as human beings. We also raise questions and criticisms about knowledge and science that may not be addressed in science classes, like whether science does provide the best guide to “the truth” and whether it is competent to guide us in shaping society and ethics.

The ultimate goal is to enable students to better understand current debates about the impact, use and misuse of biological knowledge and the roots of human nature as a means to encourage reflection on what kind of creatures we are in the great scheme of things and of what kind of world and society is best for such creatures. In achieving this end, the course seeks to provide help in reading comprehension of texts addressed to the educated public, developing essay writing skills at the college level and help students build a general historical and intellectual framework for understanding some of the major elements of western culture, necessary for enabling the development of informed and critical thought. This course thus investigates “Darwin’s dangerous idea” of evolution with a number of goals in mind:

1. **Building a general historical and intellectual framework for understanding some of the major elements of western culture.** This includes providing basic geographical knowledge, historical periodization, and some of the basic facts, dates, events, personalities, and ideas that have shaped the modern world in relation to the development of biological knowledge and scientific knowledge generally. It includes an understanding of what is meant by culture, society,
civilizations, science, philosophy, religion, Christianity, the Judeo-Christian-Islamic tradition, and, of course, biological evolution and its allied sciences.

(2) *An understanding of the basic mechanisms of Darwinian biological evolution*, especially the mechanism of natural selection, as well as the nature of the evidence supporting it.

(3) *A critical examination of the social, political and economic impact of biological knowledge*, especially (but not exclusively) of Darwin’s theory on ideas about nature, human nature, religion, the status of humans in the order of nature, free-will, determinism, the “gene-machine” concept, the concept of “soul” and mind, ideas of equality and inequality and their political and social manifestations.

(4) *A basic understanding of the nature and development of knowledge, especially scientific and biological knowledge, as distinguished from belief and faith*, including an inquiry on whether there are legitimate “limits” to scientific knowledge and religious ideas.

The list above gives us some idea of the goals of the course through a glimpse of the *course content* – the various topics and ideas we will be examining. Besides this, we will need to also to work on the means to accomplish these goals which involve the development of *basic skills* (called “competencies” in your course outlines) that are useful in any course and, indeed outside school altogether. These are skills that enable us to learn effectively on our own and become informed, educated people by developing:

(5) **Reading comprehension at the college level.** This includes help in understanding this text as well as other assigned texts addressed to the general public found online in this course’s website. Tips on acquiring background knowledge, careful reading using the double reading method, reading notes, and asking questions on assigned readings are keys to helping improve reading comprehension. Reviews and quizzes of assigned reading help acquire and assess these skills.

(6) **Writing abilities at the college level.** This includes learning the basics of essay writing, including standard essay writing form, writing introductions, thesis statements, organization, grammar problems and documentation (i.e., references or “footnotes”, Works Cited or Bibliography)

(7) **Critical and abstract thinking skills.** This includes the ability to think about ideas and to identify, question and judge their factual and logical adequacy whether in a text, class lecture or another form. Success in developing abstract and critical thinking depends partly on acquiring of factual and other knowledge provided, in part, in this course.

Other requirements for the course (assignments, etc…) are mentioned in the Course Outline as well as on the website for this course.

Almost every topic raised in this book has been the subject of literally hundreds, if not thousands, of texts. It is important to stress that a fuller account of these topics would require further study of these texts (some of which are listed in the footnotes and Bibliography). It is the
sincere hope of this teacher that this course will indeed spark interest in the topic and further reading by students.
1.4. What is Biological Knowledge?

This course does not just focus on Darwin’s theory of evolution. It examines some aspects of what we have named biological knowledge, of which Darwin’s theory of evolution is only one (albeit important) chapter. Biological knowledge is human knowledge of the living environment and includes knowledge of plants, animals, micro-organisms and human beings as well since we are also living beings. The term bios – is itself ancient Greek for “life” or “living”. Understanding living things and being able to use them has been a prerequisite for human life on earth long before Darwin, the science of biology or even science itself was invented but it is part of what biological knowledge is all about. This knowledge includes some very basic things essential to the survival of the human race from the earliest times, like, for example, knowledge about how to get or produce food, clothing and shelter. Before our age of supermarkets and box stores, people had to learn how to find and/or produce all of these. Getting food is an example of biological knowledge for two reasons: first; food is obtained from the bodies of living (bios) creatures (plants and animals) and second; it involves learning all of the skills needed to make living creatures into something useful, like food. Biological knowledge involves both human understanding and use of living beings. Thus skills like tracking, hunting or scavenging of animals, gathering of edible (eatable) plants, processing them, cooking them, are all examples of biological knowledge. Just think about the skills required even today about how to make “our daily bread”. Such skills are the product of thousands of years of accumulated knowledge about the wheat plant and how to plant, nurture, breed, harvest, care, preserve and process it into flour and safely ship it to your local bakery or supermarket. And then there is the skill, called baking bread, of how to actually transform that flour with other ingredients (some also derived from living organisms, like sugar and yeast) into something we can eat. All of this is part of biological knowledge, as is anything having to do with knowledge and use of living beings.

All of these skills require a considerable amount of knowledge – knowledge of specific aspects of the living world, or biological knowledge. Biological knowledge can be as basic and as vital as that to human survival. But it can also be as “high tech” and complicated as cloning a sheep or making “custom made babies” through genetic manipulation because this, too, involves acquiring knowledge and use of living organisms. Thus biological knowledge is as old as the human race and as new as designer babies and, like many other forms of knowledge, it has grown and developed. Today much of biological knowledge has been transformed and systematically organized into a science – the science of biology. Darwin’s theory of evolution has been crucial in turning biological knowledge into biological science. One author calls it “the key unifying idea of biology”. But we ought to remember that from the viewpoint of biological knowledge, Darwin’s theory and biological science, in general, are just one example of the continuing growth of our biological knowledge, though a rather important one!

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2 In this course we use the word “biology” to mean the modern science of biology which began in the 19th century, and the term “biological knowledge” to mean the much older knowledge of living things that began when the human race began but also includes the modern science of biology.
1.5 Darwin’s Tea Party Website

Besides this text, a key resource for students of this course is the “Darwin’s Tea Party” website. Here you will find copies of the course outline, Weekly Schedule of readings, required readings, instructions for assignments, PowerPoint presentations, videos, notes, and more. It is important to look at the website since it can help greatly in your success in the class. It can be found at the following address: http://dc37.dawsoncollege.qc.ca/humanities/gabriel
1.6 Study and Discussion Questions to Chapter 1

1. Who is Charles Darwin and what was his main contribution to biological knowledge?

2. What is the basis of the conflict between Darwin’s theory and certain religious viewpoints?

3. What is “biological knowledge” and how does it differ from the science of biology?

4. What is “biological knowledge” and how does it differ from “physical knowledge”?

5. Provide one example of biological knowledge that show why it has been important for human survival.

6. Provide one example of the impact of biological knowledge on the environment.

7. Provide one example of the impact of biological knowledge on our ideas about ourselves (human nature).

8. What does “human nature” or the “human condition” mean?

9. Are humans “special” as compared to other animals? Explain why or why not.

Group Work

10. Divide class into groups of 5. Examine section “1.2 Overview of the Course” and list 5 items in bold print your group feels it can define, describe or explain and five items your group believes it cannot define or explain (no computers or smartphones allowed!).
2. BACKGROUND AND HISTORY (2.5 mya-1859)

Sections 2.1.- 2.2 distinguish between biological and physical knowledge, provide an understanding of biological and physical knowledge in the Paleolithic period, the concept of cultural evolution, humans uniqueness, the transmission of cultural knowledge through the oral tradition, the hunting-gathering type of society and the extent of biological knowledge as evidenced by anthropology and archeology, including examination of prehistoric remains and evidence from still existing hunting-gathering societies.

2.1. Prehistoric Biological Knowledge

According to Darwin’s theory, humans evolved from other animals, gradually acquiring the physical and mental features they now have. Exactly how this happened will be examined later but here the focus will be on one key outcome of this process for humans: a larger brain compared to body size than other animals. Though a large brain may seem to be an unbeatable advantage for any species to have, most get along quite well without one as large as our own. From the evolutionary point of view, the most successful creatures defined by sheer numbers are ones that have little or no brains - for example, insects and bacteria. Having a big brain is “expensive” in terms of energy outlay and takes away from other useful defensive or offensive equipment. Thus humans have very large brains compared to their body mass, but do not have sharp claws or powerful teeth, and are slower and physically weaker than most predators. For this reason, there is difficulty understanding how humans could have evolved, according to Darwin’s view, from primates with a more “reasonable” (smaller) sized brain. The answer – again from the evolutionary point of view – must be that the advantages must have outweighed the disadvantages in the struggle for existence. Some of the most important advantages a big brain gives to humans are language.

3 After reading this section check website for PowerPoint presentation on “Prehistoric Biological Knowledge”.
foresight, imagination and knowledge. Through these abilities, humans are able not only to adapt themselves to their environment but also to adapt their environment to suit them.

2.1.1 Cultural Evolution and Human Uniqueness

Humans are a relatively defenseless species, physically, so there is little doubt that without the bone, stone and flint tools and weapons that our ancestors fashioned from their environment, we would not be here today. These inventions – the products of human knowledge of the natural environment – are like artificial extensions of the physical power of our species that more than makes up for our original bodily weakness. Thus, while nature or biological evolution has made humans deficient in their power to cut and break, humans have compensated by inventing clubs, stone knives, choppers, spears, slings and so forth. Many of these tools have been excavated from sites around the world by twentieth-century anthropologists and testify to the skill and ingenuity of our earliest ancestors. So a big brain gave humans knowledge that they could use to make the technology that helped them not just to adapt and survive in the world but eventually to re-make the world itself. This human ability to gain and use knowledge about the environment and thereby change it differentiates humans from much of the rest of the animal kingdom. The record of human inventions by which the world has thus been changed is sometimes called cultural evolution and it should be clearly distinguished from Darwin’s biological evolution. Darwin’s theory of biological evolution explains how humans have acquired a big brain and other physical features but cultural evolution explains what humans have done with that big brain. The inventions humans have made have truly changed the world but unlike biological evolution which works through transmission of genes from one generation to another, cultural evolution is a product of learning and knowledge that can be transmitted generationally or from one society to another, through social learning. This includes famous cultural inventions like the wheel, the steam engine, the light bulb, the computer or smartphone. But to this “hardware”, we also need to add the “software” of ideas and institutions like private property, Christianity, capitalism, democracy science, including the very idea of evolution itself! Many of the big changes in prehistory and history are due to all these inventions that happened when humans had already evolved into their present physical form, with the big brain alluded to above.

Thus, besides physical differences like bigger brains, different kinds of hands and fingers legs and feet, many claim more intangible differences that make our species unique and special, such as our capacity for culture, free-will or ability to shape our own destiny instead of being driven by instinct like other animals. Many have also claimed that human intelligence and rationality, imagination, morality, sociability, language ability and consciousness are unique to humans and make us special compared to all other creatures. Some also claim humans have a

5 Let’s not forget some other key differences humans have compared to our closest ape ancestors, like upright walking and the shape of the hand and thumb. The hands and thumbs of humans allow them to manipulate objects more effectively and finely than our evolutionary ancestors. Without the latter, our hands would not be able to make the tools that our brain has thought up.
“soul”. All this would seem to make humans “special” compared to all other animals and this leaves room for all kinds of speculation about human nature and who or what we truly are. But not everyone accepts that we have such unique characteristics or that we are all that special. Darwin, for one, always stressed how human abilities like intelligence and others mentioned above are also present in other animals, though to a lesser degree. As for the existence of a “soul”, some claim animal souls exist too while others reject the entire concept as unscientific. We will leave aside these important questions aside for now but will examine them further in the semester since, in many ways, they are key questions of this course.

### 2.1.2 Biological and Physical Knowledge in the Paleolithic Era

The evidence of intelligence, ingenuity, foresight and imagination of prehistoric people can be read in the remains of stone tools our ancestors have left behind during the **Paleolithic era** or the **Old Stone Age** (2.5 mya to 10,000 ya). These stone and bone tools can fossilize easily and survive intact for thousands or even millions of years such that scientists today can reconstruct some of the technical and **physical knowledge** of these early cultures. So it is clear that the earliest humans had knowledge of what kind of stones were best for specific jobs, how to cut them properly, how to give them a sharp edge and how to attach them and combine them with other materials to make them really effective. Once humans invented tools, they began to improve them and various scholars have shown how tools evolved throughout time. As we can see for ourselves, this technological evolution continues right up to today and has greatly accelerated, giving us everything from computers to cell phones to atom bombs and much more.
But even in the Old Stone Age, humans used more than stone in their technology. Besides this physical knowledge of non-living materials, they must also have learned to use the living world around them, such as wood, animal hides, bone and many other materials that come from plants and animals. This knowledge of the living world, or the living environment we have called biological knowledge, human knowledge of the living environment. Unlike physical knowledge of non-living materials like stone, biological knowledge comes from the experience human society has accumulated from the plants, animals and other living beings in their environment. Like all other kinds of knowledge, this has grown so that we now know much more about living beings and how to use them for our benefit. We have even discovered living beings prehistoric humans never imagined, such as micro-organisms like germs or bacteria and viruses. Though this discovery of micro-organisms is a recent product of modern biological science, biological knowledge includes even prehistoric knowledge of living things that stretches back thousands of years before science came upon the scene. In the prehistoric period, people didn’t have modern science or the modern science of biology. But they still had Biological knowledge which includes even non-scientific knowledge of the living things that people had of the organisms around them. More than any other animal, people rely on knowledge for their very existence and detailed knowledge of the living things in their environment was absolutely necessary if they were going to survive at all.
A graphic indicating how tools became more complex and sophisticated through time, possibly reflecting increasing intelligence and transmission of cultural knowledge.

Source Adam Benton, “Technological Evolution and Intelligence” from Filthy Monkey website http://www.evoanth.net/2012/01/14/technological-evolution-and-intelligence/

However, unlike stone artifacts (physical knowledge), objects made from living creatures (biological knowledge) decompose quickly, seldom fossilize and thus rarely leave lasting records. So, less is known about the biological knowledge of the earliest cultures than is known about their physical knowledge. What did they know about the animals and plants they hunted? What other uses, besides food did they use them for? Did they know the different properties or effects of the plants in their vicinity? It is clear that much knowledge is required even to know what is edible and inedible in the natural state, as anyone who has eaten poison mushrooms will attest. Though many books focusing on technology in human prehistory deal only with stone tools and weapons, biological knowledge was (and is) at least as important as physical knowledge as we will soon see.
Humans and even pre-human ancestors have always lived in societies. In the **Paleolithic era** (2.5 mya – 10,000 ya) while humans were evolving from earlier forms, they lived in small, nomadic groups, hunting and scavenging animals for a living using the stone tools they invented. This type of culture (or “lifestyle”) is called the **hunting-gathering culture** and is by far the longest-lived type of society humans have ever known and lasted hundreds of thousands of years. In comparison, all of recorded history (6,000 ya to the present) is less than one percent of all the time humans have been on earth. Paleolithic hunter-gatherers hunted animals and gathered wild vegetation they needed for food and other purposes. The remaining **hunter-gatherer societies** (so-called “stone age” or “primitive” cultures) still alive today give us a clue as to the extent of biological knowledge that our earliest human ancestors must have had, though the latter must have differed considerably from present day hunter-gatherer societies. At one point Western science looked down on these so-called “primitive” cultures, but today there is a better understanding and appreciation of the valuable knowledge of nature these societies had. Native
Indian knowledge of the medicinal properties of plants and animals, for example, is in fact what helped save the lives of some of the earliest European colonists to the “New World”.

The biological knowledge possessed by the earliest people was crucial to their survival and was probably attained at first by trial and error. Once language emerged, valuable knowledge (biological or otherwise) could be memorized, categorized and transmitted from one generation to the next. Knowledge would be accumulated and transmitted through this oral tradition, perhaps stretching back thousands of years. Today, anthropologists and other social scientists investigate these cultures to learn more about them and get clues about our prehistoric past. The modern science of ethnobotany inquires into the biological knowledge of these traditional societies. In the following passage, ethnobotanist Wade Davis gives us just a small glimpse of the impressive biological knowledge possessed by the Waorani indigenous peoples of the Amazon forests:

The Waorani used the sap of a tree fern as an anesthetic to soothe toothache. They dealt with botflies, a noxious parasite that burrows beneath the skin, by suffocating the larvae with a topical application of latex obtained from a forest tree. The bark of a tree in the bean family served as both a fish poison and a medicine to treat fungal infections. We also found oonta, Curarea tecumrum, the dart poison that provided the basis of their hunting technology…

Another author mentions how a tribal culture from the Congo used a plant or a tree from the local environment as a powerful anesthetic that produced no side effects to soothe pain or injury. Scientists are busy now trying to find this plant or tree. According to Michael Balick, director of the New York Botanical Garden, only 1,100 of the earth’s 265,000 species of plants have been thoroughly studied by Western medicine. However, thousands of plant species and their uses and effects are well known to native peoples. But it may be too late to retrieve this knowledge since “civilization” and science has now destroyed and displaced native people’s habitats throughout the world. The destruction of the wilderness and the cultures who lived within it also means the destruction of their valuable knowledge and ways of life.

It is ironic that modern science and western civilization which once looked down on indigenous societies is now belatedly recognizing the value of this prehistoric biological knowledge. For Wade Davis, each death of a culture is more than a lost opportunity for retrieving knowledge but is a diminishment of the human spirit and human possibilities. Like the harmful effects of the destruction of the biosphere, Davis laments the destruction of the “ethnosphere” and disappearance of different of “ways of being,” except that the harm caused by the latter is to the “human spirit” and to the human imagination.

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<http://www.ted.com/talks/wade_davis_on_endangered_cultures.html>
Prehistoric Biological Knowledge

Across

2. Not hunter
3. Science that studies human cultures
7. Such a large one not needed for most species
9. "One River" author
10. Tha family including humans and apes
11. A long time period
13. Means "living" in ancient Greek
14. An indigenous tribe of the Amazon
15. Evidence of this type of knowledge doesn't rot way as quickly
17. Old Stone Age

Down

1. Science that looks at the plant knowledge of traditional societies
4. Pertaining to spoken rather than written communication
5. Human ancestor that may have interbred with us
6. Before writing was invented
8. New Stone Age
12. It is equated with "power"
16. Our closest living relative? (Short form)
2.2 Biological Knowledge in the Neolithic Era: The Agricultural (or Neolithic) Revolution

Sections 2.2-2.3 introduces us to the Agricultural Revolution and the Neolithic period, marking the beginning of agriculture, animal husbandry and selective breeding (artificial selection) and a new form of society. Focus is on the Middle East where this began. The consequences of the Agricultural Revolution on human society are also examined, especially, population growth, specialization of labour, and growth of social inequality and how this sets the stage for the birth of civilization and beginning of history.

The traditional hunting and gathering way of life was by far the longest lasting type of society humanity has known, lasting hundreds of thousands of years. In contrast, large-scale human societies with big cities only began about 6 or 7 thousand years ago. What happened to take us out of this hunting-gathering type of culture? A series of events called the Agricultural or Neolithic Revolution led to the development of a radically new way of life no longer dependent on hunting and scavenging of animals or gathering of wild vegetation. The agricultural revolution was triggered by the invention of agriculture and animal husbandry and turned humans into food producers rather than simply food finders (plant gatherers, hunters or scavengers). Farming and raising of animals may be one of the most important inventions of the human race because of the tremendous consequences it had on human society, on the environment and on the development of human knowledge.
The development of agriculture and animal husbandry first occurred during the Neolithic era (new stone age) lasting from around 10,000 to about 6,000 years ago (ya) in the Middle East, in an area also called the Fertile Crescent. This area includes Mesopotamia, along the Tigris and Euphrates rivers, and the Nile River valley in Egypt (see map).

**Agriculture (farming) is the cultivation of food crops** and requires very detailed knowledge of specific plants and their life cycles, how to seed, plant, nourish, irrigate, maintain, breed, harvest and process them while preserving the nutrients in the soil which nourishes them. **Animal husbandry refers to the process of domestication, rearing and breeding of animals.** The animals in question include many of the familiar ones that still form a key part of our diet: cows, chickens, goats, sheep, pigs, and others. These animals not only became an important food source, but some of them were also of great assistance to agricultural work, via their muscle power, for example, and their fertilization of the soil. Thus agriculture and animal husbandry complemented one another and together were able to dramatically boost the supply of food per acre as compared with the hunting-gathering way of life.

Along with the development of agriculture in the Neolithic period, and perhaps just as important, was the process of **domestication** of certain plants and animals. **Domestication** means that the plant or animal no longer runs free in the wild but becomes part of the human “household” (domus in Latin means household) or social environment, and become dependent on humans for its survival. This is what happened to all of the familiar farm animals we know today.
But plants can also be domesticated, in the sense that they have also become a part of the human “household” and dependent on humans for their survival. This is what happened to certain types of wheat in the ancient Middle East which originally grew wild.

Eventually, because humans bred plants and animals for specific characteristics that were useful to humans but not necessarily beneficial to their survival in the wild, many of them now required the assistance of humans to reproduce. In many cases, these plants and animals can no longer survive in the wild because they have been radically transformed by humans through selective breeding or, as Darwin would have called it, through artificial selection. Selective breeding or artificial selection means the control by humans over animal or plant reproduction for specific purposes. For example, a farmer might notice that one cow produces more milk every year than the others. If he makes sure that that cow is the one who gets to mate (reproduce), he might find it produces at least some offspring which have the same characteristic (they produce more milk). Some of those offspring might even be even better milk producers than the mother. If he then takes the offspring who produces the most milk and selects that one to breed (reproduce) he will again find that some of its offspring have the same or better trait. If he repeats this process for many generations, he will wind up with cows that produce much more milk than the original ancestor. Farmers have been doing this since Neolithic times and not just to cows, but to all animals and plants that we now consume every day. Animals have been selectively bred over thousands of years for all types of physical characteristics, including size, shape, taste, muscle power, speed, and much more. They have even been bred for mental traits or behaviour. So, for example, the aurochs – the ancestor of the modern cow – was once a massive animal that was also rather aggressive and thus rather unmanageable. It has been reduced in size and bred to be much less aggressive than its original ancestor. Our modern day pets, like the domestic cat and dog, have also been bred over thousands of years (and continue to be bred now) for various characteristics. Plants and animals have changed so much since they were first bred by humans, it is sometimes difficult to recognize their original wild ancestors. This process happened to many of the animals, food plants, fruits and other key vegetable crops we now consume every day. A modern day domesticated cow can produce much milk but would probably not survive very long roaming free in the wild.

2.2.1. Consequences of the Agricultural Revolution on Human Society

Though begun on a small scale, eventually, large-scale, irrigated agriculture made a tremendous impact on the natural environment and on human society itself. Let us examine the social impact first before looking at the environmental impact of agriculture.

Agriculture eventually provided food surpluses that could sustain a far higher population density than the older hunting and gathering societies. This means more food could be extracted per square kilometer through agriculture and animal husbandry than through hunting, gathering or scavenging. Thus the human population was able to grow much faster than

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10 See website (links section) for more information on the domestication of the dog.
11 It is important to distinguish selective breeding from the modern and controversial genetic modification of food (GMF). Here we are only dealing with the relatively simple technique of selective breeding. See ch.10 for GMFs.
previously. In addition, agriculture **encouraged population growth** since, unlike hunting or gathering, the more hands you had, the more land could be farmed and the more animals could be raised. At the same time, some of the food that was now being produced could be **stored** for a long time without rotting (e.g., wheat grains). Combined with the **possibility of storing food surpluses**, the Agricultural Revolution sparked an increase in population that has never really stopped since. Some authors like Jared Diamond, question whether the entire population really benefited or was able to share in the increased availability of food – more on this later.

Agriculture also required a **sedentary (settled) rather than a nomadic existence**. One had to stay put in one place to watch over and protect the crops and farm animals. This, in turn, led to the creation of the **first permanent settlements** or Neolithic villages. Dwellings could now be built of durable materials, like mud brick which would have been impractical for nomadic people on the go who needed to travel light. The new sedentary culture also made **new inventions** possible, such as pottery and the pottery wheel, the lathe and even household objects like chairs and furniture. These objects would have been impractical for nomads. Most inventions at this stage were still made of stone and wood rather than metal (hence, the name “new stone age” or Neolithic).

Furthermore, unlike in the old hunter-gatherer societies, the **food surpluses** produced by agriculture and animal husbandry meant that not everyone needed to be occupied at getting food. Within these villages, whole new categories of people could be occupied making other things and then exchanging what they made for food (and later on for money). Thus full-time craftsmen, builders, potters, bakers, butchers, merchants, soldiers, priests and kings and many, many more **specialized types of occupations emerged**.

Thanks to the invention of agriculture, societies became far larger numerically and more complex with many people doing many different jobs. The invention of agriculture thus produced a “snowball” effect creating a society that differed dramatically from the smaller nomadic tribal hunting, gathering or scavenging societies that people had lived in for centuries. Where it emerged in the **Middle East**, people now lived a sedentary life in larger villages inside permanent dwellings with some people farming and others specializing in making certain goods in exchange for food. Food, in the form of grain and farm animals, could now also be stored and a surplus accumulated for use in times of scarcity.

But there were also some serious downsides to the new sedentary lifestyle. The increased population **meant increased health risks** as diseases could more easily spread from one person to another. Crowded conditions also created waste management problems that also encouraged the spread of diseases. Living in close quarters with animals also provided opportunities for new diseases to jump into the human population. Many deadly diseases such as smallpox, influenza, the plague and others could more easily infect humans and spread rapidly. This process continues today, as we note from headlines about the “bird flu” (H5N1) virus that has infected people throughout the world and, more recently, the H1N1 swine flu. Diseases could more easily spread because the growing population was now more crowded together in villages and increased trade put even distant people into more frequent contact with each other.
Finally, the ability to create surpluses and store these surpluses allowed for the emergence of class inequality, one of the most important issues that still confronts us today. Some were luckier in the land or resources than others or able to produce, acquire or steal more than others and find ways to maintain their resources or advantages. Moreover, the increased specialization and division of labour meant that some occupations became more highly valued or lucrative than others which also contributed to class stratification. Eventually, transfers of wealth to one’s own family or offspring helped perpetuate and augment inequality and laid the basis for hereditary chiefs and kings later in history. Accompanying and aiding the growth of inequality was the development of private property, allowing some to have legally (and militarily) enforced control over superior resources. Some authors also claim that both warfare and slavery were intensified in the transition from agriculture to civilization while intensified sexual inequality, including the subjugation of women, have also been traced back to the development of agriculture. And these were not the only serious drawbacks to the Agricultural Revolution.

2.2.2. Consequences of Agricultural Revolution on the Environment

The Agricultural Revolution also deeply modified the natural environment as lands were cleared, forests cut down and canals and irrigation works diverted rivers and streams to provide land and water for the crops. With farming, humans greatly increased their impact on the environment in many unpredictable and often destructive ways. Growing human population was bound to affect the environment in various ways. Some wild plants and animals became domesticated while others were driven out of the agricultural zones. Many animals were driven extinct but others were drawn to the concentrated food sources that the farms (and later, cities) became. Rats, mice and certain insects, for example, found a way to benefit from the food centers humans created.

None of the Neolithic farmers in southern Mesopotamia could have imagined that the new way of life they had invented for themselves with its abundance of food and new inventions would one day collapse because of environmental disaster. But this is what happened. After the
spread of agriculture along the Fertile Crescent, the land eventually became depleted because of over-exploitation and unwise management of water and other resources. The series of dams and canals built by the Neolithic farmers led to an unintended rise in the salt level (salination) of the land and depletion of water such that the crops could no longer grow\(^\text{12}\). In time, more and more of the southern part of the Fertile Crescent began to look like a desert and much of it remains so to this day. The desertification process was also intensified by climate change and human conflict in the area. Eventually, the farmers had to move elsewhere or risk starvation. And so they moved and spread the new farming technology with them.

A similar process of human growth through agriculture causing a radical transformation of the natural environment continues to this day, as development encroaches and transforms wilderness first into agricultural land and then into urban areas. This process is happening not just in the distant Amazon rainforests but in our own country as well, as the population increases and forests are cut down to make room for humans. This is perfectly illustrated by the growth of Calgary which has grown from a population of 403,000 in 1971 to well over 1 million today\(^\text{13}\). Even more damaging environmentally is the main cause of Calgary’s growth – the petroleum found in the oils sands in Alberta\(^\text{14}\).

The possibility of environmental breakdown due to agriculture and modern industry still remains a threat to our present civilization. Pollution, climate change, destruction of habitats and species and of the land itself are some of the biggest dangers mankind now faces. Though we have found ways to produce more food and more things than ever before, the means by which this is accomplished is highly destructive of the very source of that abundance. Much of our plant food, for example, is based on the massive use of oil-based fertilizers, insecticides and pesticides which create chemical pollution in our soil and water, increase carbon emission into the air and deplete the land of its nutrients. There is a high price to pay for our ability to extract more and many are now searching for healthier and more ecologically sound alternatives to help sustain the growing human population.

### 2.2.3. The Birth of Civilization and the End of Prehistory

As the agricultural system grew and expanded, the villages also grew and some became the world’s first cities which emerged about 6,000 years ago. The birth of the first cities also marks the birth of civilization\(^\text{15}\) and the beginning of writing and recorded history. It also signals the end of both prehistory and the Neolithic period. “Civilization” is a rather controversial word with many possible meanings but here it is intended only to describe a certain kind of

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\(^{15}\) As we will see this is an extremely controversial word that has often been used to make moral judgments against whole peoples and societies. We need to investigate the past use of this word and make clear that we use it in a strictly descriptive rather than a judgmental or moral manner.
society marked by large populations some of whom inhabit large urban centers and engage in many different types of occupations, exchanging their goods and services for food, money or other goods or services. It is with the birth of civilization that we first see the widespread use of writing, another revolutionary development with long-term impact on human thought and society. With civilization, humanity embarks on a way of life which marks it off even more from the rest of nature and leads to further acceleration of human knowledge and power all the way to our own civilization today. Thus in the Middle East from about 10,000 to 6,000 years ago (the Neolithic era) the Agricultural revolution laid the foundation for the birth of the first civilizations, one of the most important changes in human society with consequences also for all other life on earth and the environment.

But the story is not necessarily completely rosy. Already in the Neolithic period, society becomes unequal with some obtaining more advantages than others. In contrast to the relatively egalitarian hunter-gatherer societies, the new farming cultures became increasingly hierarchical, a process that would intensify after the birth of civilization and which continues to this day in our own world with the division between rich and poor. Thus, although more food was being produced, and more wealth too, these were not shared equally and some managed to establish themselves as rulers or kings over others. Today, we still live in the type of society called civilization and billions of people now live in cities. Civilization has become the dominant form of society in the world and has all but displaced, replaced and sometimes completely extinguished the older hunting and gathering and small-scale agricultural societies mentioned previously. Thus we can understand why the Agricultural Revolution or the Neolithic Revolution, is called a “revolution,” here meaning a series of events and ideas producing a powerful change in society.
2.2.4 Biological and Cultural Evolution (again)

Agriculture and the development of civilization, including the art of writing, science and other innovations first developed in the Ancient Middle East, in a relatively brief time and to human beings biologically like us, with brain sizes and anatomies similar to our own. They are thus major steps in human cultural evolution rather than Darwin’s biological evolution since they involve learning and the transmission of knowledge that happen over a relatively short time span rather than the transmission of genes and changes in bodies and behaviours over a very long period. Whereas the change from ape to human, with all the changes in body type and behavior this entails, is an example of biological evolution, the extensive changes we’ve examined from agriculture to civilization are examples of human cultural evolution that don’t involve much, if any physiological or physical changes in the bodies of humans. Though cultural evolution is also a kind of evolution, it is important to distinguish clearly between the two since they do not work in the same way. Cultural evolution is a product of human conscious invention and thought, while biological evolution happens to all species and requires no conscious thought at all. Another name for cultural evolution after the birth of civilization is history and like history, we are dealing here mostly with how human knowledge and activity have transformed society and nature rather than how nature (biological evolution) has transformed human beings. This will become clearer as we find out more about both biological and cultural evolution in later chapters.

Sometimes people associate the word “evolution,” whether cultural or biological, to “improvement” or “progress”. They might think that evolution means that things are getting better. But this is not necessarily what evolution means. Biological evolution is simply a way that species change and adapt to a changing environment; judging whether this is “good” or “bad” may not be a scientifically answerable question. It is also difficult to say whether the changes produced through cultural evolution are also “good” or “bad”. It is important to remember that the great changes produced by agriculture, including how it gave birth to civilization, were not all necessarily beneficial to human beings or to the natural environment. The idea that history or cultural evolution shows continuous progress or improvement may seem obvious to some but it is also strongly criticized as fundamentally wrong by many. There is indeed a great debate about whether agriculture and civilization were the greatest step forward or “the greatest mistake in the history of the human race,” as one author put it. There is also serious questioning of whether there is “progress” in history and whatever that word means. Do the positive changes caused by agriculture outweigh the negative? Look at the article by Jared Diamond and decide for yourself.

Whatever the answer, the fact is that these crucial changes were triggered in large part by biological knowledge and are examples of human cultural evolution in action rather than Darwin’s biological evolution. The development of agriculture and its role in the birth of civilization show just how important biological knowledge has been in human history and prehistory.
2.3. *In Class Essay Assignment (10%)*

Always read and re-read instructions carefully, making sure you understand and answer question(s) asked fully and adequately.

**Objective**: Write a two-page (400-600 words maximum) *double-spaced* short essay answering the questions below *in class*. Divide essay into 4-6 paragraphs. Answer in grammatically correct sentences and paragraphs. **You have 1 hour to write the essay in class.** You are allowed to bring the Jared Diamond text to class but no other material may be consulted.

**Question to answer:**

*Explain why Jared Diamond believes the agricultural revolution was "the worst mistake in the history of the human race".*

- **Main Text required**: ("required" = MUST be read before writing essay in class):
  Jared Diamond, *"The Worst Mistake in the History of the Human Race"* (Main text in pdf format)
- **Background Material required**:
  Gabriel Tordjman, *Darwin's Tea Party*, chapter 2, sections 2.1-2.4 "Prehistoric Biological Knowledge" (background text)
  Gabriel Tordjman, *"Prehistoric Biological Knowledge"* PowerPoint presentation.

**Instructions & Preparation**:

Entire essay must be written in class in one hour. **Only the Diamond reading is allowed and should be read and understood beforehand.**

- See Darwin’s Tea Party website, Assignments page, especially “Explanation and Guidelines for All Written Assignments” for help on Introductions, thesis statements, use of quotations, paraphrasing, addressing the general reader and other essay writing help. Consult teacher if questions remain. See also Tips on Essay Writing (my website) and Academic Skills Center for explanations about.
- Put your name at the top left of the page, the date and section number at the top right and the title ("Agriculture: A Big Mistake?") at the center. No cover page or bibliography is required for this essay.
- **Reading comprehension**: Use double reading method and read all material beforehand (see website, Assignments page)
  - Use standard essay form, including an Introduction with a clear one-sentence thesis statement *underlined*, body divided into paragraphs and conclusion.
- **Suggestion for Organization**: make outline including sections for Introduction and *separate paragraphs for each reason Diamond claims the AR was "mistake"*.
- **Avoid injecting personal opinion** into the body of the essay (opinion may be acceptable in the conclusion). You ought to report accurately on assigned text’s ideas, as assigned question asks.
- You may write a draft at home beforehand as practice but you may not bring this to class.
- **Revise and proofread** to correct grammar, spelling and other writing errors.
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<th>Rubric for Introductory Essay Assignment on Jared Diamond's “The Worst Mistake…” Fall 2014</th>
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2.4. Study Questions to Prehistoric Biological Knowledge

1. Map: On the map of the Middle East provided above, enter the following modern countries: Iraq, Iran, Israel/Palestine, Lebanon, Syria, Saudi Arabia, Egypt, Turkey. Enter the following bodies of water: Mediterranean Sea, Black Sea, Caspian Sea, Nile River, Euphrates River, Tigris River, Persian Gulf, Red Sea. NB: Neatness and legibility counts!

2. How did human beings make a living during the Paleolithic era?

3. What are hunter-gatherer societies?

4. What time period does the Paleolithic era cover?

5. What time period does the Neolithic era cover?

6. When does human prehistory end?

7. When does history begin?

8. Why is knowledge so important for humans compared to animals?

9. Provide one example of human physical knowledge in the prehistoric period.

10. What is biological knowledge? Provide two examples of its importance in the Paleolithic period.

11. What is animal husbandry?

12. What does domestication mean? Give an example.

Discussion, Essay or Group Questions

13. Argue either against or for the view that the agricultural revolution was the most important biological “discovery” or “invention” humans ever made.

14. Argue either for or against the view that the advantages of the Agricultural (Neolithic) revolution outweigh the drawbacks.

15. Argue either for or against the idea that the Agricultural Revolution and the birth of civilization support the view that “things are always getting better” (what Diamond calls the “progressivist perspective”)

16. Explain the key differences between cultural and biological evolution and provide examples of each type of “evolution”.

17. How is “evolution” distinguished from “progress” or “improvement”? Define your terms and provide key points of difference.

18. Group Work: Test your biological knowledge
Each group is responsible for taking pictures of 20 species. Each picture must be identified using both its common name and its binomial scientific name. (e.g., picture of a human followed by identification as human and *Homo sapiens sapiens*)
2.5 Prehistoric Biological Knowledge Puzzle

Prehistoric Biological Knowledge

Across
2. Not hunter
3. Science that studies human cultures
7. Such a large one not needed for most species
9. "One River" author
10. The family including humans and apes
11. A long time period
13. Means "living" in ancient Greek
14. An indigenous tribe of the Amazon
15. Evidence of this type of knowledge doesn't rot way as quickly
17. Old Stone Age

Down
1. Science that looks at the plant knowledge of traditional societies
4. Pertaining to spoken rather than written communication
5. Human ancestor that may have interbred with us
6. Before writing was invented
8. New Stone Age
12. It is equated with "power"
16. Our closest living relative? (Short form)
Sections 2.6-2.8 Deal with the birth of civilization as a key step in human cultural evolution and the development of knowledge, a key ingredient of which was the invention of writing. One focus is on ancient Greek civilization and especially the invention of philosophy which is presented as the ancestor of modern science. Pre-Socratic philosophers and concepts are mentioned, including atomism and materialism. Aristotle’s biological ideas are also examined as is his concept of natural slavery showing how philosophy could also be used to justify social inequality.

Thanks to agriculture, humanity was able to develop civilization, a controversial word which has been used to justify all sorts of questionable actions. Since humans lived in societies long before civilization began, it should be clear that civilization is not the same as human society. Civilization refers to a fairly recent type of human society, centered on the city as the major power center. A key element of most civilization is the invention of writing, a powerful extension of human memory and experience. Just like tools are an extension of humanity’s physical power, writing represents an extension of our mental powers. Writing emerged partly to help manage the much more complex society that civilization is. With writing, records of business transactions, land ownership and property (a new concept) and taxation (another new concept) can be kept. But it also became a way of recording the knowledge, history and literature of a society, and provides a new way of transmitting knowledge from one generation to another different than the previous oral tradition of preliterate societies (the written tradition). Thanks to writing, the experience of one generation and even a whole culture or civilization, could be more easily transferred to that of another. Through writing and the specialists who mastered it, we witness the increasing pace of scientific knowledge and technological power of human society.
that has brought us to our present position. This, of course, includes greater biological knowledge as well. Thus we can understand how writing also marks the end of the prehistoric period and the beginning of the historic time period. In short, history begins with written documents.

The earliest written records and the earliest civilizations probably originate from ancient Mesopotamia, in the ancient Middle East, along the Tigris and Euphrates rivers, about 6,000 years ago. The beginning of writing and of civilization (the beginning of history), also arose in other river valleys such as the Nile river in Egypt, the Indus river in India, the Yellow river in China and elsewhere in Asia, around the same time or shortly after the Mesopotamian civilizations. In the Americas, we have the remnants of other urban civilizations based on large-scale agriculture in central Mexico, central America and Peru. The Maya, Aztec, and Inca are only some of the more famous names of these past civilizations in this region. Though we know more about all of these civilizations than we do about prehistoric peoples since they left us written records and artifacts, relatively little has survived the thousands of years separating their time from ours. It is possible that the biological knowledge of these civilizations is far greater than we suspect. In many cases, these civilizations grew into large empires controlling extensive territories that overran earlier hunting and gathering cultures thanks to the superior technology that they were able to develop. Within these empires, we find numerous cities that are the power centers of the civilization and include a large population divided into various occupations, including a class of warriors or soldiers, priesthood, administrators, merchants, craftsmen, builders, farmers and slaves. The societies are strongly hierarchical with large differences between poor and rich and are also ruled by a small group often including a royal family and sometimes in collaboration with the upper levels of the priesthood.

As mentioned, civilization created the conditions for a huge jump in knowledge and technology among the peoples who adopted it. Some key ideas common to many ancient civilizations and that influenced their interpretation of reality also give us a clue as to how they understood what knowledge was. Not surprisingly, gods and goddesses, religion and mythology play a key role in explaining how the world worked and came to be for many of these civilizations. But one should not forget that at the same time, a great deal of scientific knowledge also was produced by these ancient civilizations. Below, we look at one important civilization which contributed greatly to the development of knowledge in western society.
2.7. Ancient Greek Civilization

2.7.1 Background: Geography and Culture

Unlike the great centralized empires of China, Egypt and Mesopotamia centered on river valley civilizations, ancient Greece was geographically fragmented, split up into chains of islands in the eastern Mediterranean and including a mainland split up by high mountains and deep valleys. In addition, Greek “colonies” had begun sprouting up all along the Mediterranean and Black Sea coasts from Spain all the way to the Crimea beginning around 1200 BC. The fragmented geography encouraged the formation not of large empires controlled by one central authority but of hundreds of small, independent city-states (Gr. pl. = poleis, sing. = polis) ruling themselves and thus developing a diverse range of political, social and cultural arrangements. Thus, for example, the city of Athens became a democracy of equal citizens (except, of course, for the large number of slaves and women who had no citizenship rights) while Sparta was the epitome of a warrior-type of tyranny. Thus there really was no one political control center of ancient Greece during the period we are interested in and all kinds of differences arose in the Greek-speaking world that might not have been tolerated had one great king or priesthood ruled the area. This might, therefore, be another example of how geography helped to shape society – this time by encouraging differences and diversity in political systems in this part of the world. This diversity and independence was an exception to other ancient civilizations we’ve mentioned and some claim it explains the greater freedom of thought that eventually resulted in the flowering of Greek classical culture and, of special importance to us, in the invention or development of philosophy, the foundation of western science and a key step in the development of biological knowledge.

2.7.2. A New Chapter in the Development of Knowledge: The Invention of Philosophy

Science is the child of philosophy with which it was strongly associated, even up to the late nineteenth century. What we would today call science, for example, was often called “natural philosophy”. Benjamin Franklin in the 18th century called his laboratory equipment “my natural philosophic instruments” while Isaac Newton and other great scientists before the twentieth century referred to their work in physics, astronomy, chemistry, as “philosophy” or

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16 Various cities did try to conquer or unify all of Greece but this didn’t happen until Philip of Macedon (359-336 BC) and his son, Alexander the Great (336-323 BC) - both of whom are outside of our main focus here.
“natural philosophy”. The birth of Western natural science, then, can be traced back to the birth of philosophy in Western culture in ancient Greece, specifically in the Greek-speaking city-states of Ionia (part of modern day coastal Turkey) beginning in the sixth century BC. The word philosophy is itself a Greek compound term including Philo (friend or lover) and Sophia (wisdom or knowledge). These Greek Ionian or pre-Socratic philosophers, as they are often called, were the first thinkers in the West to assume they could discover natural causes for natural phenomena. In other words, instead of relying on supernatural causes (gods, goddesses and the stories in myths and legends) to explain reality like other cultures had done up to then, they sought to explain reality without using the gods, mythology and religion. Instead, they assumed all of nature was an ordered system or cosmos which could be figured out by observing facts and using logic and reason. This was a new way of understanding reality since, as we have seen, up to that point the traditional and religious views held that the gods (and later, God) were responsible for everything in the natural and human world, including the universe, the planets, life, health, disease, and even various aspects of human character and emotions.

*Philosophy assumes accurate knowledge of the natural world can be obtained through the exercise of reason, logic and observation of fact.* We can see how today, modern science, makes the exact same assumptions about how the universe is an ordered system (a cosmos) and that the best way to get knowledge of how it works is by observing it carefully (getting facts) and using logic or reason. That is why we said earlier that science is the child of philosophy or, if you prefer, science is the daughter of philosophy. Though modern science is relatively new (about 300 years old), its roots go back to this birth of philosophy in the 6th century BC in ancient Greece.

Originally, the Greek Ionian philosophers focused on answering questions about the universe. Many assumed that there was a fundamental thing or substance out of which the whole universe was made so they asked: “what is the basic stuff out of which the universe is made?” Their answers differed; some claiming air, some fire, water and some claiming a combination of these and many other answers. Though we know that these were the “wrong” answers, what is more important is that they tried to provide logical reasons and facts for their answers and in this way launched the tradition of rational inquiry that were the roots or foundations of what later became modern science in the West. *The search for rational and natural causes for natural phenomena is still at the heart of modern science*, although observation, experimentation, testing, and peer review of findings, now also play key roles, as does the “scientific method” which also involves factual observation and logic to develop explanations or theories about how nature works. In this way, the pre-Socratic philosophers became the first thinkers in the West to begin distinguishing clearly between religious-mythological and philosophical (later, scientific) explanations for reality.
2.7.3. Ancient Greek Physical Knowledge: The Atomic Theory

From the very beginning, scientific or philosophic explanations of the universe and of the origins and nature of the universe differed considerably from traditional and religious explanations. One early and influential Greek theory deserves mention in this regard: the atomic theory of Leucippus (c. 440 BC) and Democritus (c. 460–c. 370 BC). This atomic theory advances the view that all matter in the universe is made up of elementary, indivisible particles called atoms (Gr. atomos). In other words, all things, living and non-living, are the result of differing combinations of these atoms. This conclusion is reached partly by logical deduction rather than observation. For example, it is reasonable to assume that things cannot be divided forever into tinier and tinier bits; there must be a starting point somewhere to material things. That starting point is an atom and everything in the universe is made up of them. Today, the atomic theory is one of the central concepts in the natural sciences (including physics, chemistry and biology). However, modern atomic theory is considerably different from what the ancient Greek atomists had speculated. Atoms are no longer considered hard, tiny particles as even Newton speculated centuries later in England. Furthermore, modern atomic theory is based not just on reasoning and deduction which these ancient philosophers stressed, but also on observation, induction, experiment and the use of highly complex instruments, obviously unavailable to these ancient philosophers. But, again, if these ancient Greek thinkers turned out to be “wrong” in some of their conclusions, they still were important in trying to develop explanations that relied on logic and reason rather than on religion, tradition or supernatural explanations, still the heart of modern science today.

2.7.4. The Philosophy of Materialism

Influenced by the atomic theory, some philosophers of the ancient world took it one step further. Some developed the idea called philosophical materialism or the materialist philosophy which claims that everything in the universe is nothing but matter in motion. By matter, they meant only that which could be seen, touched, heard, felt or smelled; or, in other words, what could be detected by our senses. These were sometimes also identified as made up of the atoms mentioned above. Nothing else existed for philosophical materialists but matter. This philosophy, still influential in modified form today, ran into serious conflict with religious authorities since materialism directly contradicted key religious beliefs in the existence.

\[17\] Nor are they even the smallest particles, as 20th century quantum physics tells us.
of gods and goddesses (or later, God) which could not be seen and were often understood as non-material entities. In later ages, materialists also denied the existence of any non-material kind of soul or spirit. Thus materialism has always been closely associated with *atheism*, the belief that there are no gods, goddesses or God.

Natural philosophy and science have often been accused of promoting a materialist philosophy but this is not strictly true if we pay attention to the differences between science (natural philosophy) and materialism. Natural philosophy, as mentioned above, seeks to explain natural events by references to natural causes. Those causes and events are indeed “material” in the sense that they are tangible things we can “see” or record somehow but unlike materialism, natural philosophy or science do not claim that this is *all* that exists. Indeed, claims about “all that exists” are beyond the reach of factual observation since no one is able to record all that exists. Since materialism goes beyond observable facts it should, therefore, be described as a “metaphysical philosophy” rather than a *scientific theory*. “Metaphysics” means literally “after” or “beyond” physics or nature, meaning beyond what can factually be observed. Natural philosophy seeks to understand reality by use of facts and logic but materialism strays beyond these and should not be equated to science or natural philosophy.

2.7.5 Ancient Greek Biological Knowledge: Aristotle

The ancient Greeks also applied the method of philosophy to the living world around them, and thus greatly helped to develop our biological knowledge. Perhaps the greatest of observers in this regard was the philosopher **Aristotle** (384-322 BC) who stressed the importance not just of deduction and logic, as many of his contemporaries did, but also of factual observation. Many of his books advocated close study and observation of living creatures and included titles like *On the Generation of Animals*, *On the History of Animals* and *On the Parts of Animals*. Although he did not have many of the instruments we now have, such as the microscope, many of his findings remain true to this day, for example, his view that dolphins and whales were not the same as fish.

2.7.6 Aristotle’s Critique of Materialism

Aristotle rejected the atomic theory because it assumed all things were an accidental result of combinations of atoms, and thus could not account for how highly *organized* things were. **For Aristotle, things were not just made up of matter but also of form which was responsible for giving them their organization.** For example, a wooden chair is made up of matter – the wood in the chair. But it also has the characteristic chair form, which comes from the carpenter’s plan or mind. Without the form of the chair, it would not be a chair but some other thing or just a pile of wood. Form, which is non-material, is as important as matter for Aristotle. This is especially clear when dealing with living beings. Any animal is a highly
complex whole made up of many parts. The parts, like organs, tissues, limbs and muscles are all made up of matter but their characteristic functions and the fact that they all work together in a highly organized manner are a product of form, not matter. The organization and working together of all these parts could not be the product of random atoms just happening to join each other but require a form giving property which is not the same as matter. Neither could a purely material explanation of things explain how animals or plants reproduce or grow. This again seemed to require a form giving property, or a formal cause. Today, science explains the same facts, including those relevant to the organization of living beings in very different ways. Aristotle, however, was on the right track in focusing not just on what material things were made up of but also what could explain their organization, structure, function and form.

2.7.7 Aristotle’s “Three Souls Concept”

Aristotle’s "Three Souls" Concept

<table>
<thead>
<tr>
<th>Besides a vegetative and sensitive soul, humans also have a rational soul, providing us with the ability to reason and shape our own destinies.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Besides a vegetative soul, animals also have a &quot;sensitive soul&quot; for movement, sensation, drives and instincts.</td>
</tr>
<tr>
<td>Plants have &quot;vegetative soul&quot; for nutrition, growth and reproduction.</td>
</tr>
</tbody>
</table>

Another important contribution Aristotle made to biology was the classification system or taxonomy he devised for all things or beings. At the most general level, Aristotle divided all things somewhat like the guessing game “animal, mineral, vegetable”. Within this three-part classification was the crucial one between living and non-living beings; non-living inanimate beings like rocks and minerals were fundamentally different from living or animate beings like plants and animals. All living beings require food, grow and reproduce but non-living beings do not. Animals and plants could be differentiated by the fact that plants had only a “vegetative soul”, for growth and reproduction, while animals also had a “sensitive soul” for movement and sensation. Animals also do not get nourishment from air and soil like plants. Among the animals, only humans had, in addition, a “rational soul”, located in the heart. Each individual animal or plant belonged to a group that had the same essential properties that made them part of that group and no other even if they differed.

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slightly from each other. For example, even if you look different from your neighbour, both of you still share the same essential properties that make you human. Essential properties could include whether an animal had four legs or two, and a host of other physical features. Only humans had rational thought as an essential part of their nature. For Aristotle, this meant that although animals could be quite intelligent, only humans could reflect on and answer questions about their own being through philosophy, as he had done. This power of rational thought was a divine gift and a part of human nature or essence that made humans different than the other animals. Humans (or at least some of them) are thus set apart from the rest of the animals in Aristotle’s philosophy. Human’s rational or intellectual abilities make them “special” or “higher” than the rest of the natural world. On this particular point, as we will see, Darwin disagreed with Aristotle.

2.7.8 Aristotle’s Classification of Life

Aristotle’s work prepared the way for the famous two name system (binomial) devised by Carolus Linnaeus (1707-1778) in the 18th century. Linnaeus distinguished between genera and species. In this way, he began to categorize animals and plants into related groups and subgroups based on observed similarities. In everyday language, species is roughly equivalent to “kind of animal” so that humans are one “kind of animal” while cats are another “kind of animal”. But scientifically, one needs to be more precise than this. Species are creatures that share many common characteristics and can only reproduce with each other. Thus, all humans are members of one species, called Homo sapiens in Latin, who share many common characteristics and who can potentially reproduce with each other to produce children. Similarly, all house cats are members of the house cat species called Felis catus and can reproduce with each other to create kittens. House cats cannot reproduce with humans or other species and this is one key way to define and distinguish one species from another. The second word in the two name term (sapiens or catus) identifies the species name while the first word designates its genus name. A genus (plural, genera) is a group of different species that share commonalities. Dogs (Canis familiaris), for example, share many common characteristics with wolves (Canis lupus) and other existing wild species of the Canis genus. Similarly, Homo sapiens (humans) also share some
common characteristics with other species, such as their prehistoric ancestors like *Homo erectus* or *Homo habilis* that lived millions of years ago.

...and dogs (Canis lupus familiaris or Canis familiaris) are the common name of another species and house cats (Felis catus) yet another. Everyone can see that dogs resemble wolves and jackals and in fact, they are part of the same family (Canidae) and genus (Canis) while being of a different species than wolves or jackals. Long after Aristotle, other scientists will further develop a classification scheme that will group together species and genera according to similarities and differences, something even more difficult to do with plants and flowers, however, it is only with Darwin’s theory that we arrive at a satisfactory scientific explanation as to why animals and plants can be grouped, divided and subdivided in such ways.

2.7.9. Aristotle, Men, Women and Slaves

Aristotle did not neglect human beings in his studies of living things. But here, his conclusions provoked much controversy in our own time. This is especially the case in his attempts to understand the differences between men and women and between slaves and citizens. We have already mentioned how humans rate highly in Aristotle’s philosophy since only humans

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[20] There is actually controversy over whether dogs are a separate species from wolves or whether they are both the same species, with the dog being merely a variety or breed of wolf.
have the rational mind to be able to philosophize in the first place. However, he does not see this as equally true for all humans. Aristotle seems to begin by taking for granted and “natural” the inferior status of women and slaves then trying to find a “natural” or biological explanation for it. Unlike previous writers, Aristotle claims that only the male contributes “seed” to create the next generation and the female’s contribution appears to be less important than the male’s. The male contribution, says Aristotle, is what gives form to the offspring in the sense of giving it the things which are distinctly human, like a rational soul. The male contribution is “active” while the female’s contribution is merely supplying “passive” material for the active form-giving male seed to work on. Here again, we note the importance of form and matter in Greek philosophy with “form” seen as higher or better than matter. Given this supposed biological reality, Aristotle claims, males are intended by nature to rule because they receive more of the rational mind necessary to rule properly. Women receive rational mind too, but apparently insufficient or incomplete to rule a household or a state. In short, “The male is naturally fitter to command than the female…and age and maturity are similarly fitter to command than youth and immaturity.” For Aristotle, the female seemed like an immature or incomplete male and this could and was easily used to justify the lower position of women in society.

2.7.10 Philosophy: Accurate Explanation of Reality or Excuse for Social Inequality?

It is important to note here how natural philosophy is being used to explain not just how nature works but why human society is the way it is. In the process, Aristotle winds up justifying a basic inequality of his own society. By “justifying” is meant here, providing a false excuse or wrong reason, though there is no need to assume Aristotle did this intentionally or consciously. Since Aristotle was the most influential philosopher in the Middle Ages and even up to the beginning of the modern period, his conclusions about men and women carried much weight far beyond the ancient period and beyond the borders of ancient Greece. Today, we know much more about the biology and genetics involved in reproduction and most people know that both males and females contribute an equal complement of chromosomes and genes to the offspring. Genes and chromosomes are what provide “form” to the growing embryo, foetus, and child. Both males and females thus contribute equally to the “form” and “matter” that produce offspring. There is also no evidence that women are less able to develop their rational abilities if given the opportunity.

Aristotle’s concept of natural slavery fails to question the assumptions of inferiority of slaves and women and tries to justify this inequality by providing a supposedly philosophical or scientific reason showing it is “natural”. Besides the inferior status of women, a huge section of the population of ancient Athens were slaves who were either born into slavery or were made into slaves as a result of defeat in war. While most Athenian citizens considered turning losers in war into slaves normal and right, some raised the issue whether some people were made “by

nature” to be slaves or whether slavery was unnatural and simply a result of the strong imposing their will on the weak. Aristotle considered this question too and his answer was that

“just as some are by nature free, so others are by nature slaves, and for these latter, the condition of slavery is both beneficial and just”\textsuperscript{22}.

Aristotle claims that some people simply lack sufficient rational mind to lead worthwhile lives and these would be natural slaves. These, he identified as “barbarians” or non-Greek speaking people. On the other hand, some were natural masters and intended by nature to rule over others. These he identified as Greek speaking males.

About two thousand years after Aristotle’s death, during the early Modern period, slavery had almost disappeared in Europe. However, this was also when Europeans began to colonize the New World. There was a need for labour to work on the agricultural estates and plantations the Europeans were imposing on the New World. In Spain, a controversy arose over whether the native people the Europeans encountered in South America could be enslaved and forced to work for the colonizers. One side argued against this, citing Christian principles but the other side argued in favour, citing Aristotle’s concept of “natural slavery” for support\textsuperscript{23}. In this way, Aristotle’s concept of “natural slavery” continued to make an impact, long after his was revived at the beginning of the modern period.

It is important to remember that the great accomplishments of ancient civilizations like the pyramids of ancient Egypt, the Parthenon of Athens and even the invention of philosophy, were based largely on the social, economic and political inequalities that provided immense wealth for some and ceaseless toil for others. This was the case for the inequalities between men and women which meant that women in ancient Greece were often given charge of the raising and caring of children and received little education and no opportunities for participating in their society at all. In Athens, women could not even be seen in public unaccompanied by males. This seems to underline a rather important theme in this book: the powerful influence of social prejudices and faulty assumptions in the development of scientific knowledge. This is not just a question about Aristotle’s work. We will see how natural philosophy (science) in general has been repeatedly used to justify inequality in society and the domination of one group over another, warning us that the growth of knowledge has always also been accompanied by the growth of power, including the power of some human beings over other human beings.


2.8. The End of the Ancient Period

The ancient Greek culture was eventually absorbed by the expanding **Roman Empire**, centered in Italy. The Romans were deeply influenced by Greek philosophy, science, technology, art and even the Greek religion. They tried to maintain the scientific and philosophic traditions of the ancient Greeks and added to it in some quarters. Their empire also stretched into the areas of ancient Egypt and part of the ancient Middle East and also benefitted from knowledge from those civilizations. But after the collapse of the Roman Empire in the West around 470 AD, much of the accumulated knowledge of the ancient world was lost. Civilization broke down as a result of invasion and warfare. Cities were depopulated as society returned to a simpler rural based way of life. Even the art of writing was almost lost for a time. But a new, powerful force remained from the Roman times and was to have a major impact on the development of philosophy, science, biology and ethics. This was the **Christian church**\(^{24}\).

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\(^{24}\) By “Christian church” at this point, we mean the Roman Catholic Church in the West. Other Christian churches arose in Eastern Europe (various Christian Orthodox churches) and, much later, various Protestant movements.
2.9. Ancient Biological Knowledge Puzzle

Across
2. Earliest part of history
4. This word is based on Latin for urban center
5. "Love of wisdom"
6. The world's first cities civilization?
9. This theory says this can't be divided
11. Birth of philosophy home
13. Basing conclusions on facts
16. One of Mesopotamia's most famous rivers
18. Socrates died here
19. They succeeded and also emulated the Greeks in many ways.
21. Central American pyramid builders
22. Genus name of cat
23. An urban center

Down
1. "Beyond physics"
3. The philosophy that says if you can't seem, hear, touch, smell it, it's not real
7. Home of the pyramids
8. Not induction
10. The first kind of writing?
12. This begins with writing
14. Greek word for ordered universe
15. Egyptian river
17. Where the "300" are from
20. Author of "On the Generation of Animals"
2.10 Study Questions to Ancient Biological Knowledge

1. In what way is Agriculture a “prerequisite” for civilization? Why is agriculture needed first before civilization can emerge?

2. What is the name of the world’s first civilization and where was it located? Why do you think civilization emerged there first?

3. List all of Aristotle’s contributions to biological knowledge mentioned in this chapter.

**Group Questions:** Contact your group members and provide a one paragraph collective (group) answer to any one of the following questions to present to the next class. Each member of the group should work on and revise a common draft to present to the class. (2 points)

1. Civilization can mean many things and the concept has been used to justify the oppression or domination of some groups over others. Can you identify examples of how civilization has been used in this way?

2. How do we use the concept of civilization in this class? Does our definition of civilization contain any value judgments? How is it defined?

3. Civilization is credited with providing humanity with incredible marvels like the pyramids and the Parthenon, as well as with a tremendous boost to the development of knowledge but the economic basis for these achievements was slavery and sexual inequality. What is your view of the value of civilization given these facts?

4. Why is the “invention of philosophy” such an important chapter in the development of knowledge? What were the key things it helped to establish?

5. Materialism has at least two key meanings, the “common” and philosophical meaning. Explain what each is and explain whether your group subscribes to (believes in) any of the two meanings of this concept and why.

6. Though Aristotle was one of the wisest philosophers the world has ever produced, he still developed the concept of “natural slavery”. What important lesson do you think we can draw from this?

7. “Google” the following: “Bartolome de las Casas”. Examine, especially his view on the atrocities and exploitation committed against the native people of the Americas by his own and the viewpoint of his opponent during the debate. How is Aristotle relevant at all to this debate?
2.11. Religion, Science and Philosophy in The Middle Ages

Given the key role the Church played in medieval society, it is not surprising that the philosophical approach to reality was eclipsed and religious or supernatural explanations of reality were revived. The universe and all living and non-living things in it were understood as originally created by God, according to the teachings of The Christian Bible and the Church fathers. Society itself was seen as having been established by God, as we will see below. In some respects, this resembled what had existed before the beginning of philosophy, when explanations for the universe and for life were dominated by religious ideas.

However, the Greek and Roman philosophical approach did not completely disappear. In fact, Greek philosophy, especially the ideas of Plato (427-347 BC) and Aristotle (384-322 BC) were eventually rediscovered and made a deep impact on the Christian Church, especially after the recovery from the "Dark Ages" following the collapse of the Western Roman Empire.

Though materialism and mechanism were rejected as contrary to common sense and the word of God, Church writers rediscovered the philosophical tools of logic and factual evidence in the interpretation of reality. They even used these mental tools in the interpretation of the Bible itself. Ultimately, the medieval understanding of society actually combined Greek philosophical ideas with Christian ones. This is important to remember since many people wrongly assume that the Church was always hostile to philosophy and science. It is also incorrect to assume that there was no scientific or technological progress in the Middle Ages. One invention, the heavy plough revolutionized food production. Other inventions include the tidal mill, the hour glass and the mechanical clock.

2.11.1. Revealed Theology and Natural Theology

We can see how Church writers used philosophy and logic even in trying to interpret religious texts like the Bible. The interpretation of religious texts is called theology or revealed theology and many of the Church fathers sought to resolve apparent inconsistencies and puzzling passages in the Bible with the help of logic and the philosophical approach. In many cases, they developed allegorical or symbolic interpretations of many parts of the Bible, including allegorical or symbolic interpretations of the creation story in Genesis. But even more revealing of the philosophical influence on Christian ideas in the Middle Ages is what is called natural theology. Unlike revealed theology which focuses on the Bible, natural theology focusses on study of the natural world and in this sense was much like natural science or natural philosophy. However, the purpose of natural theology was not simply to acquire knowledge of nature for its own sake, but to acquire knowledge of nature that could logically "prove" the existence of an all-wise, all-powerful Creator. In other words, natural theology is the philosophical investigation of nature dedicated to logically proving the existence, wisdom, power and goodness of God. Thus two kinds of theology existed – revealed theology, based on the Bible containing the “book of God’s word” and natural theology, based on the study of nature and containing “the book of God’s

25 The Middle Ages covers the period from about 470 AD to 1450 but the “Dark Ages” include only the first few hundred years of this, following the collapse of the Roman Empire in the West (see Timeline).
works. According to Christian commentators like St. Thomas Aquinas (1225-1276), revealed theology assumed that certain types of knowledge could be had only by faith alone and these were revealed in the Bible. Natural theology, on the other hand, could provide knowledge that could be demonstrated logically or empirically (factually). For Aquinas, these were the basis of two truths that were not contradictory. Both traditions were believed compatible and complementary to each other and left a lasting impression on religious belief even up until our own time.

Natural theology proposed various arguments claiming to logically “prove” God’s existence. Only two will be mentioned here:

1. the argument from design
2. the cosmological argument

The argument from design noted how the universe and all things in it seemed masterfully designed for life. The eye of the eagle or the hand of man seemed masterpieces in construction no human artist could ever match. Even today, no engineer or scientist can create anything close to what a human hand or an eye can do. And because a hand or eye includes many different parts, all organized and coordinated together for an obvious purpose, explaining such structures as a result of chance or accident seemed highly unlikely. The complexity and coordination of these aspects of living things lead to the simple proposition that they bore the marks of design, not accident. Since there appears to be design in the universe, there must, therefore, be a Master Designer, i.e., God. Hence we have what seems to be a philosophical or rational proof for the existence of God.

The cosmological argument also utilized logical and rational arguments to argue for the existence of God. The main premise was that everything in the universe had a beginning in time. The second premise was that everything that has a beginning in time must have a cause. From this logically followed that the first cause for everything must be God.

These arguments show that, unlike what many people believe, the Church was not necessarily hostile to rational and logical thinking. Natural theology, as we have seen, encouraged both close observation of nature and logical thought, crucial to the development of science when it emerged later in the modern period. In this sense the Church played a positive role in the development of science and biology, laying the groundwork for future developments. The idea, echoed by many scientists even to this day, is that knowledge of nature inspires a feeling of reverence or awe for her Creator, God.

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26 These expressions were invented by Francis Bacon but are quoted by Darwin at the beginning of his Origin.
27 Today, new versions of the argument from design continue. One most famous proponent is Michael Behe whose book Darwin’s Black Box (Free Press, New York, 1996) tries to argue that certain bacteria could not have evolved from simpler forms but are “irreducibly complex” and that this suggests they were designed by a superior intelligence. “Intelligent Design” advocates continue to claim that living things show evidence of design and therefore, an intelligent designer. Despite all the new details and facts provided all of them still make the same basic argument indicated above.
2.11.2 Humanity’s Central Place in the Cosmos According to the Geocentric Theory

The **geocentric theory** is the theory that all heavenly bodies, including the sun, circle around a motionless earth at the center of the universe. It formed the accepted picture of the universe for hundreds of years and for many reasons. The geocentric theory fits into what certain Bible passages seemed to assume about the motion of the planets and stars. They also fit in with what some ancient Greek authorities had also assumed. For example, **Aristotle** and **Ptolemy** (Greek philosopher of the 2nd century AD) both assumed the **geocentric theory of the universe**. We should also not neglect “common sense”. Before the discovery of the law of gravity and laws of motion, it would have been hard to accept the idea that the earth spins on its own axis and that this is why the stars and planets seem to circle the earth. Didn’t the sun “rise” and “set” across the sky every day as seemed clearly obvious to even casual observers? Hadn’t the stars of the night sky been observed to do likewise as had been recorded at least since the ancient Babylonians and confirmed by (most) ancient Greeks? Thus Greek philosophical ideas were made to square both with Christian religious views and with “common sense”.

![Geocentric System](http://spiritualmeanderings.files.wordpress.com/2010/05/ptolemaicsystem.png)
Most importantly, all of these viewpoints expressed a key *theological or religious* point that the Church insisted upon: **human being’s central position in the universe.** Since God had made humans “in his image” and was His most important creation, it was natural to suppose the earth was necessarily and literally center stage in the universe. From the religious viewpoint at the time, how the universe was organized was not just a strictly technical or scientific question but reflected the Christian message that humans were at the center of a drama that God had created. The earth’s centrality served as a lesson about the *meaning of life* for human beings on earth.

Greek and Christian ideas were especially compatible on the issue of human’s central position in the universe. As previously mentioned, according to Aristotle, only humans had a **rational soul** and were, therefore, superior to all other animals. The Christian Church accepted this idea of rational soul as a necessary and obvious attribute of human beings. Thus both the geocentric theory and rational soul supported the viewpoint that humans as a species were “higher” and different than the rest of nature and thus occupied center stage in the universe.

### 2.11.3 The Great Chain of Being

The Christian conception of human nature thus postulated that human beings were the highest of God’s creations, just “lower than the angels,” as written in Psalm 8 because of our rational soul, consciousness and moral free-will. Indeed, an entire ladder of creation or **Great Chain of Being**, also influenced by Greek ideas, was imagined which placed God at the summit of all creation, followed by other divine beings and humans. Below humans were the rest of the earthly creations in an ordered series from the “higher animals” and the animate world of life to the inanimate world of plants, then non-living rocks and matter at the very bottom. In this scheme, non-human animals possessed no rational soul and no consciousness and the higher beings were said to rule or be superior to the lower.

This hierarchy of beings neatly summarized the highly **anthropocentric** (“human-centered”) view of the universe that characterized Christian thought up to Darwin’s time. From this picture of the universe, all of creation led up to man and God and all of nature was interpreted as having been created by God “In the beginning” for the use and benefit of human beings, as reflected in the opening chapters of the book of Genesis. All of nature had been designed with a divine purpose or goal (a *telos*) – all leading up to humans.

Another important point about this Great Chain concept was the assumption that God had assigned to each “kind” of being its “proper place” in this vast chain. All together they formed a continuous “ladder of nature” (*scala naturae*, in Latin) from lowest to highest all leading up to God. Thus there could be no gaps or voids, no missing steps in this ladder. This means that no
species could go extinct and no new species created since God had executed the whole plan of the Great Chain perfectly from “the beginning”. This idea was bound to run into conflict with the later discovery of fossils showing animals that no longer seemed to exist. It also ran into conflict with the idea that species were immutable under natural law, as put forth by such figures as the Roman naturalist Lucretius, who argued that life was a self-perpetuating chain of matter, without the possibility of change. The idea that species could evolve was already very old in Europe, as exemplified by the medieval picture of the Great Chain of Being according to Didacus Valades, *Scala Naturae* (1579). At the top is God, seated with Christ. Below God are the higher, then the lesser angels. Below the angels are humans, half way between divine and material. Below the humans are the animals, then the plants and finally, the rocks and minerals. Below all of this is hell. Not the fallen angel on the right who becomes more monstrous as he gets closer to hell.

with Darwin’s evolutionary theory that used the fossils as evidence for the continuous extinction and evolution of new species. His theory of evolution struck a fatal blow to this time honoured view of the cosmos (see also Chapter III on arguments for evolution based on fossil evidence).

### 2.1.1.4 The Great Chain and Medieval Society

The Great Chain of Being also provides us with an insight into the social and political structure of medieval society. The Chain was a **cosmic hierarchy** but it also reflected the **social and political hierarchy** that existed at the time. Just like God was the ruler of all creation and each step on the ladder “ruled over” the lower steps, so it was that medieval society, especially under the social system called **feudalism**, was also a hierarchy with kings ruling over nobles and knights who, in turn, ruled over their serfs (landless peasants who worked the land). Each person belonged to a specific social group and each social group had its “proper” place on a specific rung on this social ladder. The idea that one could rise above one’s group or “proper” place, though it sometimes happened, was not seen as desirable or right since it was believed that the whole cosmic and social hierarchy was established by God and thus should not or could not be upset or changed. A person belonged to the social class and social role within which he or she was born, with the interests of the group seen as more important than the individual’s interests and the interests of the whole hierarchy or society as more important than any single social role.

Source: “Duffy Sterling’s teaching Stuff, ”
http://duffystirling.files.wordpress.com/2012/06/feudal-pyramid-of-power.png
group. Of course, the reality was that medieval and feudal society was highly unequal with only a few possessing great wealth and comfort while the huge majority worked to exhaustion and in poverty to provide for their “betters”. The Great Chain concept thus served as a kind of mirror reflecting the reality of social inequality in medieval society. At the same time, it blessed this arrangement as supposedly natural and God-given. As we will see, Darwin’s theory was also used in a similar way – to claim that social inequality was a product of nature’s will.

The Great Chain of Being, by lining up all creation in a hierarchical order does bear some resemblance to an evolutionary series. But this resemblance is superficial since no one in the Medieval period would claim that a species could move from one rung of the ladder of creation to a higher one, or from one link of the chain to another. God, it was assumed, had created and appointed each and every being to its rightful place in the Great Chain from the beginning and for all eternity. All of the species He had created could neither be changed nor moved. Just like the eternal stars in the sky, the world of life was pictured as static (unchanging) rather than dynamic (changing) world and the animals and plants that humans observed were assumed to have remained unchanged since their creation. This static view of the cosmos matched perfectly with the static view of society – everything and everyone had a proper place and there was a proper place for everything, all originally designed by God.

Finally, we also recognize how the Great Chain concept echoes what is already there in the Christian view of the universe: that nature is there for humans to use. Animals and plants and the rest of creation are believed to have been created to supply human beings. As stated in the book of Genesis: “Then God said, ‘Let us make man in our image, in our likeness, and let them rule over the fish of the sea and the birds of the air, over the livestock, over all the earth, and over all the creatures that move along the ground.’”\(^{28}\) This also agrees with what Aristotle stated in the ancient period: just like some humans are intended by nature to rule over other humans, humans as such are intended by nature to rule over nature.

The static, anthropocentric assumptions of the Great Chain, as well as the Great Chain concept itself, would soon be severely tested in the modern period. The same is true for the argument from design. Darwin’s theory would eventually provide a major challenge to these ideas.

\(^{28}\) Genesis 1:26, The Bible. Revised International Version
http://www.biblegateway.com/passage/?search=genesis%201&version=31
2. BACKGROUND AND HISTORY (2.5 mya – 1859)

Spread of Christianity and Buddhism (top map) and of Islam (bottom map) to 760. Not shown is further spread of the religions after 750 AD.
2.12. Medieval Biological Knowledge Puzzle

Medieval Biological Knowledge Puzzle

Gabriel Tordjman

Across

2. The key idea in Medieval Europe
4. Early Medieval social system
7. Doesn’t move or change
12. Human centered
14. Greek philosopher influential in medieval view of universe

Down

1. First book of the Bible
3. These creatures were most important according to Medieval view
5. Argument claiming complex, organized things require this
6. Ladder in Latin
8. Ordered universe
9. Ranking from highest to lowest
10. Prefix for "earth"
11. Study and interpretation of Sacred texts
13. The argument from the First Cause
2.13 Study Questions to Medieval Biological Knowledge

1. Explain why or how supernatural explanations of reality returned to prominence during the beginning of the Middle Ages?

2. What is “[revealed] theology,” “natural theology” and the “argument from design”? Is it a convincing “proof” for you of what it claims to “prove”? Why or why not?

3. Read this short article that supports the argument from design and uses the human eye as support. Is it convincing to you? Why or why not?

4. Explain how the geocentric theory fit into the Church’s overall understanding of humanity’s place in the universe.

5. What is the Great Chain of Being? Explain how it fits into anthropocentric ideas found in Aristotle’s philosophy and Christian theology?

6. In what sense does the cosmic hierarchy of the Great Chain of Being reflect the social hierarchy of Medieval feudal society. Is this another example of ideology?

2.14.1: Birth of the Modern Period (1450-1650)

By the end of the 15th century, the authority of the Catholic Church was coming under increasing attack. Already, during the Renaissance, a rebirth of the ancient Greek and Roman writings was triggering a revolution in thinking among the educated classes. The voyages of discovery by Columbus and others made it clear that the world was vaster and more diverse than anyone had supposed up to that point. One vital invention had an enormous impact on religion, science and learning in general: the printing press. Invented in the late 15th century, it greatly facilitated the copying, printing and dissemination of books (previously copied by hand). More people could now gain access to books – including the Bible, now also being translated into the vernacular (the language actually spoken and read by the people), instead of Latin. This was partly responsible for religious conflict, the Protestant Reformation and the wars of religion between Catholics and Protestants during the 15th and 16th centuries. But the printing press also allowed a much wider and freer circulation of other kinds of literature and knowledge, including scientific knowledge. Important economic changes were also taking shape. The increasing trade, commerce and plunder, due in part to the expansion of the European empires during and after the voyages of discovery, gave a powerful boost to the capitalist economic system. This disrupted the old idea that God had assigned everyone to a specific social class or social role since, huge fortunes could be made by individuals who were daring and ruthless enough to seize them. All of these developments intensified the sense that the old medieval world was dying and a new one was being born. Especially important for us as a background to understanding Darwin is the Scientific Revolution, centered in the 17th and 18th centuries which we will examine below.

2.14.2. Francis Bacon and Induction

Most important, in this context, was the contribution of science and philosophy to new ideas about the nature of life and humanity in the universe, now made more widely available thanks to the printing press. The English philosopher Francis Bacon (1561-1626) has often been called the apostle of modern science. He rejected what he felt was the futile and ineffective scholarly debates of the past, including the influence of the greatly respected Aristotle. Bacon saw both ancient Greek science and medieval philosophy as too influenced by the method of deduction which began not with facts and observation but with assumptions or premises. His view was that modern science or natural philosophy ought to throw off the overly theoretical speculations of medieval Church scholars called the scholastic philosophy, or scholasticism and

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29 Let’s not forget that literacy was a rarity at this point (15th and 16th centuries). Possibly less than 5 percent of the population of Europe could read, even in the vernacular. On the other hand, these were often the most powerful people.
focus on facts and observation of the natural world to make science more reliable and useful to society. For Bacon, science ought to proceed by the method of induction that stresses unbiased observation and collection of facts to arrive at more general statements (hypotheses or theories) that could explain these facts. For example, if every time you flick a switch, a light comes on, you can safely arrive at the conclusion that the cause of the light coming on is the flicking of the switch. Induction was, up until the 19th century, a basis for “the” scientific method. Darwin himself claims at times to have followed strictly “Baconian methods” in establishing his evolutionary theory. But even Darwin confessed that he could never have arrived at his evolutionary theory simply by using Bacon’s inductive methods. In the 19th and 20th centuries, various philosophers and scientists began to question whether science really does advance by this inductive way. Deductive methods are

Bacon was clearly mistaken when he implied that Aristotle himself cared little for observation of nature and was more apt to create unsupported theories, though perhaps Aristotle’s followers in the Middle Ages could more justifiably be accused of this.
now accepted as at least as important as induction in science.

Bacon also wanted science to become more “useful” to society and he looked forward to the day when scientific inventions would be used to increase the comfort and wealth of society. In this sense, Bacon foresaw the powerful technological and economic potential of science and reflects both the modern scientific and the modern capitalist ways of thinking.

2.14.3 The Revival of Mechanism: The Universe as a Machine (1650-1850)

Bacon’s rejection of Aristotle favoured instead the rival mechanical explanation of the universe. For example, instead of explaining growth and sensation of animals by “vegetative” and “sensitive souls” as Aristotle had, Bacon was among the first to compare the cosmos and animals to machines, like clocks. In his book *Novum Organum* (1620), he states that “the making of clocks... is certainly a subtle and exact work: their wheels seem to imitate the celestial orbs, and their alternating with orderly motion, the pulse of animals”.

The discoveries of the Belgian physician Andreas Vesalius (1514-1564) and the British physician William Harvey (1578-1657) on the human and animal body seemed to confirm the idea that living things also functioned like machines. Harvey’s discovery of the circulation of the blood and the pump-like action of the heart are early examples of how the mechanical metaphor seemed to be gaining ground.

But the most well-known mechanist of the 17th century was the French philosopher, René Descartes.

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(1596-1650) who extended the mechanical view to include all of nature and living things, including the human body. Descartes rejected Aristote’s notion that plants had a “vegetative soul” and animals had a “sensitive soul” (see above). In his famous *Discourse on Method* (1637) he states:

> I wish you to consider... that all the functions which I have attributed to this Machine, such as digesting of meats, the beating of the heart and the arteries, nourishment and growth, respiration, waking, and sleeping; the reception of light, sounds, odors, tastes, warmth, and other similar qualities, into the exterior organs of sensation; the impression of the corresponding ideas upon a common sensorium and on the imagination... and finally the external motions of all members of the body [are] neither more nor less than the movements of a clock or other automaton... so that it is not necessary, on their account, to conceive within it any vegetative or sensitive soul.

Descartes, however, stopped short of considering the human mind or soul as another type of machine. The soul was radically different in essence from the rest of the mechanical world and, as a gift of God, allowed reason and thought to exist in humans. Thus Descartes is also known as having established a radical distinction between soul and body or a mind/body dualism. All of the universe and living things operated according to mechanical principles, the unique exception being the soul or mind of man and the will of God.

### 2.14.4. Triumph of the Heliocentric Theory and the Scientific Revolution

Though the mechanistic idea was the target of considerable religious and scientific opposition, the 17th century *Scientific Revolution* seemed to confirm it, at least in the minds of many philosophers. The story begins with the overthrowing of the geocentric (earth-centered) theory and its replacement by the new heliocentric (sun-centered) theory of the universe. For centuries, the accepted philosophical and religious wisdom was locked into a coherent and unified geocentric cosmology that pictured the earth as the center of the universe around which all the planets and stars revolved. The new heliocentric theory proposed by the Polish natural philosopher, Copernicus (1473-1543) pictured all the planets, including the earth, revolving around the sun instead. Though Catholic religious authorities had long interpreted many Biblical passages symbolically and metaphorically, certain passages, apparently implying a geocentric view, were interpreted more literally, thus putting them in direct contradiction to the new heliocentric theory. When Galileo Galilei (1564-1642), who supported Copernicus’ heliocentric theory, published his own findings, the Church viewed this as a direct attack on its authority. Galileo was arrested and forced to recant. Galileo’s support for heliocentrism might not have elicited such opposition by religious authorities had it been proposed at a different time. But in

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33 There are no precise dates for the Scientific Revolution, but it is centered on the 17th century, the period in which Galileo, Newton and other natural philosophers firmly established the sciences of astronomy, physics, mathematics and the heliocentric theory.
34 One famous example, in *Joshua* 10:12-14, where Joshua is said to have commanded the sun and the moon to stand still, implying the motion of these bodies around the earth rather than the reverse.
Copernicus’ model of the heliocentric universe. This picture is from the book where he outlined this theory, called De Revolutionibus orbium coelestium (On the revolutions of the heavenly bodies) published in 1543. Ever since, the word “revolution” has meant not only a loop around a center but a rapid change in life and thought. Indeed, the book marks the beginning of the Scientific Revolution.

the 16th and 17th centuries, the Church’s authority was already being challenged on a number of fronts and this seemed to be a case of drawing an intellectual line. Despite Galileo’s persecution and his being placed under permanent house arrest, by this time it was too late to stop this new scientific view of the world triggered by the heliocentric theory. The Catholic Church could not, in any case, enforce its viewpoint on countries which were no longer Catholic, like, for example, Britain. The eventual triumph of the heliocentric theory constituted the key series of events we call the scientific revolution. Of course, this scientific revolution would eventually spread to other domains of knowledge besides astronomy and mathematics.

In Britain, Isaac Newton (1642-1727) completed the first phase of the Scientific Revolution by establishing a convincing mathematical and physical description of the universe. His discovery of the law of gravity and the three laws of motion, one of the greatest scientific discoveries in history, confirmed the heliocentric theory and finally overturned Aristotle’s and Ptolemy’s geocentric theory. Where before a multiplicity of independent and conflicting theories were provided for the motion of objects on the earth or in the heavens, Newton showed how all of these were simply instances of his neatly and concisely formulated laws of motion and gravity.
Furthermore, these laws could be used to predict, accurately and reliably, the future position and trajectory of objects in space or on earth. Like Galileo, Newton’s methods had stressed observation of nature and experiment rather than the authority of ancient books and favoured the precision and clarity of mathematics. The importance of experiment and observation, as Francis Bacon had already stated, were considered more valuable sources of factual knowledge about nature rather than reliance on the “wisdom of the ancients”, including Aristotle. They also conformed to Bacon’s ideals of induction - the observation of facts, uncluttered by previous dogma as a guide to formulating more general theories. However, Newton had also used mathematical deduction to arrive at his scientific conclusions.

Newton and the other major scientists of the Scientific Revolution were important not just for their discoveries but also for establishing a method (using observation, experiment, mathematics, induction and deduction) of arriving at general truths about nature which virtually defined science for the next two hundred years. Though this explains, in part, why some scientists resisted Darwin’s evolutionary theory in the 19th century. Evolution bore little resemblance to what Newton had done.

2.14.5 The Philosophical Impact of the Scientific Revolution

Galileo and Newton were perhaps the first scientific heroes of the modern age. Newton was the first scientist ever to be knighted and his fame spread, deservedly, across Europe and all over the world. Some enthusiastic poets, like Alexander Pope, claimed that

Nature and Nature’s laws lay hid in night;  
God said, Let Newton be! and all was Light.

However, later poets blamed Newton for eliminating the mystery from the universe, replacing it by cold number and measurement. The poet Keats, for example, accuses “philosophy” (science) of “unweaving a rainbow” in reference to Newton’s work on optics, (which showed how white light is a combination of all the colours of the rainbow) wrote

Do not all charms fly  
At the mere touch of philosophy?  
There was an awful rainbow once in heaven:  
We know her woof, her texture; she is given  
In the dull catalogue of common things.  
Philosophy will clip an Angel’s wings,  
Conquer all mysteries by rule and line,  
Empty the haunted air, gnomed mine -  
Unweave a rainbow…

35 The importance of mathematics is expressed in the title of Newton’s most famous book, Mathematical Principles of Natural Philosophy published in Latin in 1687 and in English in 1729. We can thank (or blame) Newton for the invention of the calculus, too.
The new scientific picture of reality assumed a “clockwork universe” which could operate on its own according to natural laws, without the necessity of God’s constant intervention. Some took the mechanistic philosophy one step further and concluded that even the mind of man was a type of machine and that the soul of man was a fiction. The philosopher Julien Offray de La Mettrie in his book *L’Homme Machine* (Man as a Machine, 1748) argued that humans, like animals, were “soulless machines” and saw no need for assuming that God had provided humans with souls. He described humans as “at bottom only animals and perpendicular crawling machines”\(^{36}\).

By the middle of the 19\(^{th}\) century, it seemed clear not only that neither earth nor humanity occupied the center of the universe, but that a new, powerful way of understanding reality had emerged. This new understanding seemed to support a materialistic, mechanistic and deterministic philosophy which not only explained the motion of bodies in space and time but also offered a new philosophy of life that far different than the traditional religious picture.

However, for Newton the new science was not a magic key that would instantly reveal all the secrets of the universe. Indeed, he was forced to defend himself against the charge that he had not explained gravity itself by stating that this was as much as his “experimental philosophy” allowed. Newton was perhaps impressed more by the *limits* than by the extent of scientific knowledge.

> I do not know what I may appear to the world, but to myself, I seem to have been only like a little boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.\(^{37}\)

In a letter to a fellow experimental philosopher, Robert Hooke, Newton stated that “If I have seen further it is by standing on the shoulders of giants”. By this, he credited others who had come before him and whose insights and findings had paved the way for his own discoveries. This is an important point about modern science because it clearly shows that the greatest scientists during Newton’s time did not claim to be able to discover all the secrets of the universe and all the mysteries of the human mind. For people like Newton, religion still played a crucial role in solving the ultimate mysteries, especially those involving God and human beings.

### 2.14.6 The Birth of the Scientific Community

By Newton’s time, science had become the affair not of isolated individuals but of a *community of scientists* spread across Europe and working and competing with each other. Without the constant communication (especially through letter writing but also printed books) between men of science, no major scientific discovery would have occurred. Correspondence between scientists, often from different countries, allowed for more rapid accumulation of facts and knowledge and testing of theories and hypotheses. Experiments and observations in one country were reported in other countries and these were often repeated and tested. Scientific knowledge from various sources could thus be collected and become subject to multiple

\(^{36}\)Vartanian, pp.205, 206.

\(^{37}\)Boorstein, p.404.
verification and testing. Institutions, like the Royal Society in Britain (founded in 1660 and presided over by Newton for 25 years), the Académie Royale des Sciences in Paris (founded in 1666) and others were established to promote this “new philosophy” and make science “useful” to the state and society.

Today the scientific community has grown to include university programs, research institutions, professional organizations and thousands of specialized and general peer-reviewed publications throughout the developed world. Much of this work is financed by government and private interests and much of it geared to making science “useful” and profitable to society. Scientific findings are published in such journals and verified by other scientists continuously. According to some philosophers of science, it is the scientific community that should be seen as the judge of what we ought to call “science” or non-science. The advance of science and technology today testifies to its enormous impact and “success”. But we should not forget that this “success” is only understandable in the context of a capitalist society like ours which stresses economic rewards for successful invention and not just understanding for the sake of “pure” knowledge, as it often was in the past. We also ought not to forget that there is often a high environmental and human impact to pay for this “success” Finally, as will be shown, though science became a powerful model for obtaining truth in any field of inquiry, it was not immune to serious distortion and prejudice. Especially when dealing with human beings and human differences, science produced a number of very harmful myths that we will examine later.
2.15 The Scientific Revolution Puzzle

**Scientific Revolution Puzzle**

**Across**

3. Western discoverer of circulation of the blood
6. Logical rule for thinking, even without facts
7. This guy says if we knew everything in one moment we could totally predict the next.
9. Comes from Latin word “to know”
11. Sun centered theory
12. Historical period between Medieval and Contemporary

**Down**

1. “I think, therefore I am” dude
2. For mechanists this worked like “clockwork”
4. Christian group that broke away from Catholic Church
5. Italian put under house arrest for claiming earth moves
8. “God said, ‘Let _____ be! and all was Light!”

10. Inductively proven good with eggs
11. This philosophy says everything works like a machine
14. A British Society dedicated to advancement of science
2.16 Study Questions to the Modern Period and the Scientific Revolution

1. List some key developments that explain why historians view the period from 1450-1650 as the birth of the modern period.

2. Francis Bacon is known as a stronger promoter of induction as the path to discovering truth. What is induction and what is deduction?

3. What is the “mechanistic view of the universe”?

4. Explain the first phase of the Scientific Revolution (focused on astronomy and physics), including the overthrow of the geocentric theory by the heliocentric theory.

5. Why was the Church so resistant to accepting the heliocentric theory?

6. Explain how the Scientific Revolution helped re-establish a “mechanistic” view of the universe.

7. Why did some philosophers or artists condemn the increasingly dominant role that science assumed by the 19th century. What did they accuse science of spreading?

8. Does science “unweave a rainbow” according to you? What does that mean and what is your response to this perspective on the science?

9.