

Have Scientists Discovered G-D?

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Resumo

Recentemente, tornou-se claro para muitos cientistas que o universo parece ter sido complementado especificamente para a existência e bem-estar do ser Humano. Este fenômeno tornou-se conhecido como o “princípio antrópico” (derivado da palavra grega “antropos” que significa homem). O princípio antrópico expressa-se de duas formas: 1. Ligeiras mudanças nas leis da natureza tornariam impossível a existência de vida; 2. A vida humana não teria sido possível senão pela ocorrência no passado de um grande número de eventos improváveis. Em contraste com a perspectiva dos cientistas não crentes, mostra-se que é válida e justificada a posição daqueles que vêem no princípio antrópico a confirmação da sua crença no Todo-Poderoso.

Introduction

In recent years, it has become clear to many scientists that the universe seems to have been specifically designed for the existence and well-being of Man. This phenomenon, which has attracted considerable scientific attention, has become known as the anthropic principle,^{1,2} from the Greek word *anthropos*, meaning “man.” The anthropic principle expresses itself in two ways: (1) very slight changes in the laws of nature would have made it impossible for life to exist, and (2) human life would not have been possible if not for the occurrence in the past of a large number of highly improbable events. Whereas the secular scientist sees these occurrences as mere lucky accidents, the believing person sees in them the guiding hand of the Creator.

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Our subject consists of two parts: an explanation of exactly what is meant by the anthropic principle, and a discussion of its importance for the believing person. The first topic is purely scientific, whereas the second topic deals with religion. This distinction must be kept clear because the words commonly used by secular scientists in discussing the anthropic principle often sound remarkably similar to those used by rabbis!

The thesis to be developed here is that the anthropic principle - the idea that the universe seems to have been designed for the existence and well-being of man - may be taken as evidence that the universe *really was* so designed by the Almighty. This statement requires a detailed explanation and justification, because secular scientists view the anthropic principle as merely a curious property of nature, having no significance whatsoever. Therefore, it is important to understand why the believing person is justified in seeing in the anthropic principle a confirmation of his belief in the Almighty.

I. The laws of nature and the existence of life

The anthropic principle refers to the discovery of a remarkable connection between the laws of nature and the existence of life. A relationship between the principles of biology and the existence of life is not surprising, but one would not expect to find such a relationship when it comes to the physical sciences. However, new discoveries have shown that the existence of living creatures is intimately dependent on the details of the laws of physics, astronomy and cosmology.

I.1. Solar Energy

It is not necessary to elaborate on the fact that life on earth is crucially dependent on the sun, whose heat and light are the primary source of all terrestrial energy (aside from radioactivity, which is not relevant to our discussion). Without solar energy, our planet would be incapable of supporting life. Therefore, we begin our discussion of the anthropic principle by examining the mechanism that produces the sun’s energy.

The sun contains only two kinds of atoms: hydrogen and helium. Helium is inert, unconnected with solar energy, and therefore need not concern us further. Our discussion centers on hydrogen, the simplest atom, whose

nucleus consists of only one proton. Thus, the sun is basically a vast assemblage of protons. How protons produce solar energy was first explained in the late 1930s by Professor Hans Bethe, who was awarded the Nobel Prize for his discovery. Bethe was a German Jew, and like so many other Jews, he was dismissed from his university post by the Nazis in 1933. He settled in the United States and joined the physics faculty of Cornell University, where he made his Nobel Prize-winning discovery.

Because of the extreme conditions present in the interior of the sun, a proton may occasionally transform spontaneously into a neutron, another fundamental particle of nature. The resulting neutron can combine with another proton to form a composite particle known as a deuteron. These deuterons “burn” via a thermonuclear reaction, and this provides the intense heat and brilliant light of the sun. Thus, deuterons constitute the solar fuel that generates the energy of the sun which enables life to exist on earth.

A very important feature of solar “burning” is that it occurs very gradually. Since neutrons are only rarely formed from protons, a relatively small number of deuterons are produced at any one time, and thus solar fuel (deuterons) constitutes but a tiny fraction of the total material in the sun. This ensures that the sun burns slowly, generating solar energy only gradually.

Another possible nuclear reaction that could, in principle, occur is the combination of one proton with another proton. Fortunately for us, however, such proton-proton combination does not occur. If one proton were able to combine with another proton, then all the protons in the sun would immediately combine with each other, leading to a gigantic explosion of the entire sun.

The possibility of proton-neutron combination and the impossibility of proton-proton combination both depend on the strength of the nuclear force, one of the fundamental forces in nature. The other fundamental forces include the familiar force of gravity and the electromagnetic force. Detailed calculations of the nuclear force have demonstrated the following results:³

1. If the nuclear force were only a few percent weaker, then a proton could not combine with a neutron to form a deuteron. If this were the case, no deuterons would be formed in the sun, and hence, there would be no solar fuel. As a result, the sun would not shine,

but would merely be a cold ball of inert protons, precluding the possibility of life on earth.

2. If the nuclear force were only a few percent stronger, then each proton would rapidly combine with another proton, with explosive results. If this were the case, the sun would explode, once again precluding the possibility of life on earth.

It is an extraordinary fact that the strength of the nuclear force *just happens* to lie within the narrow range in which neither of these two catastrophes occurs. The proton-proton explosion of the sun *does not* occur, but the gradual burning of deuterons *does* take place in the sun, providing the warmth and light that are vital for life to exist on earth. This is our first example of the anthropic principle.

1.2. Water and Air on our Planet

It is not necessary to elaborate on the necessity of water and air for the existence of life. The Earth is blessed with an abundant supply of both, permitting life to flourish here, whereas our two neighboring planets, Venus and Mars, are both devoid of water and air, and hence devoid of life, as the space program has established. These facts may not seem particularly noteworthy, but we shall show just how remarkable they really are.

It was recently discovered that, shortly after they were formed, all three planets (Earth, Venus and Mars) had large amounts of surface water. The deep channels that are observed today on the surface of Mars were carved out long ago by the copious fast-flowing Martian primordial surface waters.⁴ Similarly, Venus was once covered by deep oceans that contained the equivalent of a layer of water three kilometers deep over its entire surface.⁵ However, in the course of time, all surface waters on Mars and Venus disappeared. How did our planet escape this catastrophe?

The surprising answer is that the Earth escaped this catastrophe by sheer accident! Earth *just happens* to be sufficiently distant from the sun that our surface water neither evaporated nor decomposed, as happened on Venus. Moreover, Earth *just happens* to be sufficiently near the sun that the temperature remains high enough to prevent all the oceans from freezing permanently, as happened on Mars. Therefore, Earth *alone*, among the planets of the solar system, is capable of supporting life.

Similar remarks apply to the atmosphere. Recent studies have shown that the planetary atmosphere is controlled by a very delicate balance, involving the subtle interplay of many factors.⁶ This balance is so delicate that if the Earth were only slightly closer to the sun, the surface temperature would be much higher than the boiling point of water, precluding all possibility of life. Similarly, if the Earth were only slightly farther from the sun, the concentration of carbon dioxide in the atmosphere would become so high that “the atmosphere would not be breathable by human beings.”⁷ Fortunately, the Earth’s orbit *just happens* to lie at the crucial distance from the sun that permits the formation of a life-sustaining atmosphere (“life could appear in this extremely narrow zone”⁸).

This remarkably fortunate coincidence is known among scientists as the “Goldilocks problem of climatology.” Recall the children’s story in which Goldilocks entered the home of the three bears and found the various items of Baby Bear to be “not too hot and not too cold....not too hard and not too soft....not too long and not too short....but *just right*.” In the same vein, scientists view the existence of water and air on Earth as another example of the anthropic principle.

1.3. Physics and Astronomy

The two examples of the anthropic principle presented above are taken from the many that could be brought from the physical sciences. Indeed, the examples are so numerous and so dramatic that many scientists have commented on the severe restraints that the existence of life places on the laws of nature. Particularly perceptive are the impressions of Professor Freeman Dyson of the Institute for Advanced Study in Princeton, whose words capture the essence of the anthropic principle: “As we look out into the universe and identify the many peculiarities of physics and astronomy that have worked together for our benefit, it almost seems as if the universe must in some sense have known that we were coming.”⁹

1.4. The Origin of Life

The branch of science that deals with the origin of life is called molecular biology. There has been enormous progress in the past few decades. Scientists have unraveled the structure of DNA (the long, thread-

like molecules that form the genetic material found in each cell of every living creature) - the famous double helix. The genetic code has been deciphered. Hundreds of complex chemical reactions that occur within the cell are now understood. From all this scientific progress, one could easily form the impression that the “riddle of life” has been solved; in other words, that scientists have succeeded in explaining all the steps by which inanimate material became transformed into the complex biological systems that we call life. However, such a conclusion would be completely erroneous.

After half a century of intensive research into molecular biology, scientists have come to appreciate how extremely improbability and incredibility of the transformation of inanimate material into living cells. This was the central theme of a recent *Scientific American* article, appropriately entitled, “In the Beginning.”¹⁰ This article describes the enormous difficulties encountered by all current scientific proposals to explain the origin of life (“points out the inadequacy of all proposed explanations of a terrestrial genesis of life”), quoting leading experts in the field.

Professor Harold Klein, chairman of the U.S. National Academy of Sciences committee that reviewed origin-of-life research, is quoted as follows: “The simplest bacterium is so damn complicated that it is almost impossible to imagine how it happened.”¹¹

Professor Francis Crick, who shared the Nobel Prize for discovering the structure of DNA, is also quoted as using picturesque language: “The origin of life appears to be almost a miracle, so many are the conditions which would have had to be satisfied to get it going.”¹²

If this Nobel laureate, known as a man completely devoid of any religious feeling, sees fit to use the words “almost a miracle” to describe the origin of life, it is clear that quite an incredible series of unlikely events must have occurred to transform inanimate material into living cells.

2. Highly improbable events and human beings

2.1. The Destruction of the Dinosaurs

Thus far, we have been discussing the many unlikely events that were necessary to make possible the existence of life itself. But our main concern is, of course, with human life. Therefore, we ask: Did any extremely unusual

events have to occur to permit the existence of human beings? As we shall see, the scientists' answer is a resounding "Yes!" This is the very heart of the anthropic principle.

We begin our analysis of the highly improbable events that culminated in human life with a discussion of the dinosaurs, those terrible monsters of the past. The dinosaurs were one of the most successful groups of animals that ever lived - the largest, strongest, fastest, and fiercest animals of their time. Dinosaurs (and their close relatives) inhabited every continent, the air (flying dinosaurs) and the oceans (marine dinosaurs). All other animals lived in constant fear of being devoured or destroyed by these gigantic reptiles. Because the dinosaurs dominated the earth, this era is referred to as the Age of Reptiles.

After being the undisputed masters of our planet for over 150 million years, the dinosaurs suddenly became extinct. The sudden destruction of all the world's dinosaurs, together with most other animal species, is the most famous of the mass extinctions that have occurred periodically in the history of our planet, each time abruptly wiping out the majority of animal species. The cause of this mass extinction had baffled scientists for many years. What could have caused the abrupt demise of these extremely successfully animals after they had enjoyed such a long period of dominance? What happened to suddenly wipe out all the dinosaurs?

After years of debate, the riddle of the sudden and total destruction of the dinosaurs was solved in 1980 by Nobel laureate Luis Alvarez and his son Walter. These scientists showed that a giant meteor from outer space collided with the earth to cause this worldwide catastrophe.¹³ This explanation for the mass extinctions - the impact of meteors or comets colliding with the earth - has become known as the impact theory. Evidence in favor of the impact theory accumulated rapidly, and by 1987, Professor Alvarez could point to *fifteen* different pieces of scientific data that support this theory.¹⁴

The point of central importance to our discussion is that the collision of the meteor with the earth was a matter of *sheer luck*. This has been repeatedly stressed by the leading paleontologists (scientists who study fossils). Professor David Raup, past president of the American Paleontological Society, took precisely this point as the central theme of his famous article (later expanded into a book with same title), entitled *Extinctions: Bad Genes or Bad Luck?* Raup emphasizes the importance of luck in mass extinctions:

"The extinction of a given species is more bad luck than bad genes...Pure chance would favor some biologic groups over others."¹⁵

The important role played by luck in mass extinctions has also been emphasized by Professor Stephen J. Gould of Harvard University: "If extinctions can demolish more than 90% of all species, then we must be losing groups forever by pure bad luck."¹⁶

Professor George Yule of the University of Oxford puts it in the following way: "The species exterminated were not killed out because of any inherent defects, but simply because they had the ill-luck to stand in the way of the cataclysm."¹⁷

Finally, we quote Professor David Jablonski of the University of Chicago, a renowned authority on the subject of mass extinctions: "When a mass extinction strikes, it is not the "most fit" species that survive; it is the most fortunate. Species that had been barely hanging on, suddenly inherit the earth."¹⁸

These leading paleontologists are emphasizing that if a giant meteor suddenly falls from the sky, wiping out some species while permitting other species to survive and ultimately to flourish, then the Darwinian principle of the survival of the fittest is irrelevant. The species that survived were blessed with *good luck* - the occurrence of an extremely improbable and totally unexpected event.

2.2. The Dinosaurs and Man

What is the relationship between the dinosaurs and human beings? Why does the sudden destruction of all the dinosaurs worldwide constitute a dramatic example of the anthropic principle? The explanation is straightforward. As long as dinosaurs dominated the earth, there was no possibility for large mammals to exist. Only after the dinosaurs were wiped out could the mammals flourish and become the dominant fauna.

This intimate connection between human beings and the dinosaurs was emphasized by Professor Alvarez, who ends his article about the meteoric impact that destroyed all the dinosaurs, with the following words: "From our human point of view, that impact was one of the most important events in the history of our planet. Had it not taken place, the largest mammals alive today might still resemble the rat-like creatures that were then scurrying around trying to avoid being devoured by dinosaurs."¹⁹

But there is more to the story. For human beings to exist today, it was not sufficient that our planet was struck by a meteor. The impact had to have occurred with *just the right strength*. As Alvarez writes: “If the impact had been weaker, no species would have become extinct; the mammals would still be subordinate to the dinosaurs, and I [Alvarez] wouldn’t be writing this article. If the impact had been stronger, all life on this planet would have ceased, and again, I wouldn’t be writing this article. The impact was just the right strength to ensure that the mammals survived, while the dinosaurs didn’t.”²⁰

2.3. “Wonderful Life” by S. J. Gould

It has become clear to scientists that the sudden destruction of the world’s dinosaurs was just one of a long series of completely unexpected, highly improbable events whose occurrence was necessary for human beings to exist - and that *all these events just happened to occur in precisely the required sequence*. This is a major theme of the book entitled *Wonderful Life* by Professor Stephen Jay Gould of Harvard University. Again and again, Gould emphasizes how amazing it is that human beings exist at all, because “we are an improbable and fragile entity...the result of a staggeringly improbable series of events, utterly unpredictable and quite unrepeatable.”²¹ His 320-page book abounds with examples of the anthropic principle:

Consciousness would not have appeared on our planet if a cosmic catastrophe had not claimed the dinosaurs as victims. In a literal sense, we owe our existence, as large reasoning mammals, to our lucky stars.²²

Let the “tape of life” play again from the identical starting point, and the chance is vanishingly small that anything like human intelligence would grace the replay.²³

It fills us with amazement (because of its improbability) that human beings exist at all. Replay the tape a million times from the same beginning, and I doubt that *Homo sapiens* would ever appear again. It is, indeed, a wonderful life.²⁴

3. Calculating probabilities

Having described in detail the scientific meaning of the anthropic principle, we now turn to the second part of the discussion and ask: What are the implications of the anthropic principle? In particular, what are the implications for the believing person?

I would like to begin the discussion on a personal note. A decade ago, I wrote a book on Genesis and science entitled *In the Beginning*, showing that current scientific evidence is in remarkable agreement with the biblical account of the origin and development of the universe. My book has enjoyed a measure of success, having been reprinted thirty times and translated into nine languages.

However, the book was not to everyone’s taste. Professor Raphael Falk, geneticist at the Hebrew University and a militant secularist, was so outraged by my book that he published a ten-page article, devoted *solely* to attacking both my book and me personally (“fundamentalist,” “commits scientific rape,” “writes pseudo-science,” “manipulates facts, etc.”²⁵). In particular, Falk ridiculed my discussion of the anthropic principle by means of the following counter-argument:

Aviezer places particular emphasis on the “remarkable coincidences” which characterize the universe. The point of this claim is that such remarkable events could not have occurred through chance, but rather are the result of a guiding hand. Superficially, this claim appears convincing, but a little thought shows that that it is without foundation. According to Aviezer’s logic, the probability that I am writing these lines with a dull yellow pencil, using my left hand, sitting at my kitchen table, on the third floor of a specific Jerusalem address - this probability is completely negligible. Nevertheless, all these events happened and they clearly mean nothing.²⁶

It is important to explain what is wrong with Falk’s argument, because his error is not immediately obvious and, in fact, has been repeated by other writers. For example, this same error appears in an article on the anthropic principle,²⁷ written by a distinguished philosopher who is also an observant Jew. This author brings the following example:

I pull a \$1 bill from my wallet and observe its serial number to be G65538608D... The probability for this occurrence was less than one in ten billion. Thus, undeniably, *I am faced here with an extremely rare*

event, but I am not surprised. What is essential is to make the crucial distinction between *improbable events that are genuinely surprising and those that are not* (italics added).

I have italicized the two erroneous statements. The first italicized statement is simply wrong. We shall soon see why we are *not* faced with a rare event. The second italicized statement is meaningless, because *all* improbable events are surprising. Indeed, that is what is normally meant by the word “surprising.”

The key to understanding this topic can be found in the words of Nobel laureate Richard Feynman, one of the most brilliant physicists of the 20th century. In his marvelous book on quantum electrodynamics (in which he explains this most complex of theories simply and without the use of a single equation!), Professor Feynman emphasizes that:

“In order to calculate correctly the probability of an event, one must be very careful to *define the event clearly*.”²⁸

3.1. Defining the Event

Following Feynman’s advice, we shall clearly define the event described above, which immediately leads to the conclusion that there is a probability of 100% that the dollar bill pulled from the wallet has G65538608D for its serial number! Why? Because this number was chosen *after looking* at the serial number on the bill. In other words, one was simply asking, “What is the probability that the serial number found on the bill is the serial number on the bill?” And the answer to this question, clearly, is 100%. Since the event was not improbable at all, but certain, there is no reason to be surprised by its occurrence.

Let us now apply the same logic to invalidate Falk’s argument. What was the probability that Falk wrote his article on his kitchen table, using a dull yellow pencil held in his left hand, on the third floor of a specific Jerusalem address? The answer is: 100%! Why? Because Falk *chose* these unusual conditions on the basis on what he *already knew* to have happened. In other words, Falk simply asked, “What is the probability that what I know to have happened, really did happen?” The answer is clearly 100% - by definition.

A rare, extremely improbable event occurs if one defines the conditions *before* knowing what will happen. For example, if one chooses a serial number

before pulling a dollar bill from his wallet, and then finds that the number chosen is exactly the same as the number on the bill, we would all be absolutely astonished - and with good reason! Similarly, if Falk had guessed correctly all the conditions under which *someone else* had written an article, then we would all be flabbergasted - and rightly so.

3.2. Events in Context - Playing the Lotto

We now turn to the second important aspect of Feynman’s statement: *events must be defined in context*. An example will illustrate this point.

Among the popular Israeli lotteries is Lotto. Say, for concreteness, that one million people buy a Lotto ticket each week. If I am informed that this week’s winner is Haim Cohen from Tiberias, I will certainly not get excited about it. But why not?

The chances that Haim Cohen would be the winner were only one in a million - and it happened! The reason for my lack of excitement is the following. I could not care less if the Lotto winner is Haim Cohen from Tiberias, Sarah Levi from Be’er Sheva or Shmerel Berel from Ramat Gan. In other words, each of the one million Lotto players is completely equivalent in my eyes to Haim Cohen from Tiberias (the technical term in statistics is “equivalent microstates”). Although the chances were only one in a million that the winner would be Haim Cohen from Tiberias, there exist one million “equivalent” Haim Cohens. Therefore, the substance of what I heard is that *someone* won the Lotto this week. And the chances for that event happening - *someone* winning - are 100%. Hence, I have no reason to be surprised.

Now consider the following week. If I were informed that Haim Cohen *again* won the Lotto, I would most certainly be amazed, and so would everyone else. But why? The chances of Haim Cohen winning the Lotto the second week were exactly the same as his chances of winning the first week. The answer is that the *context* is entirely different. In the first week, Haim Cohen was just one of a million equivalent Lotto players. But in the second week, he was a *unique* individual - the fellow who won last week. In other words, in the second week, there exists only *one* Haim Cohen - only *one* previous week’s winner - and the chances of this unique individual winning the Lotto again are truly one in a million. When such a rare event occurs, we are all genuinely surprised.

Finally, we turn to the third week. If we were to learn that Haim Cohen had *again* won the Lotto, for the *third* consecutive week, it is clear that *suspicion*, not surprise, would be the natural reaction. Indeed, there is little doubt that the fraud division of the police department would soon be paying a visit to Haim Cohen to discuss with him just how it happened that Haim won the Lotto for three consecutive weeks.

But why? The chances of Haim Cohen winning the Lotto in the third week were *exactly the same* as his chances of winning the first week. The answer lies in the *context* of the event. By the third week, Haim Cohen has become an *extremely* unusual individual - the fellow who has already won the Lotto for *two* weeks running. The chances that this same person will win the Lotto *once again* are easily shown to be only one in a million millions (1000 billion). Such events are so rare that they simply *do not occur*. Therefore, the police department correctly suspects that a guiding hand was behind Haim Cohen's triple win. A guiding hand in the creation of the universe means the intercession of the Almighty, but a guiding hand in the determination of the Lotto winner means five years in Ramla Prison!

3.3. Events in Context - Playing Cards

We next consider card games, beginning our discussion with the game of poker (five-card poker without a draw). In this game, each player is dealt five cards from the deck, and these cards form a combination (pair, three-of-a-kind, flush, etc.). Each combination has an agreed ranking, and the game is won by the player whose cards form the highest-ranking combination.

The highest ranking combination of cards in poker is the straight flush (it is not necessary to know what a straight flush is). A straight flush is so rare that one can play poker all day, every day of his life and never encounter one. And if a poker player should ever get a straight flush, he will never forget it. There is nothing more wondrous in poker: the dream of every poker player!

We now turn to a different card game, bridge. In this game, each player is dealt thirteen cards, but we will consider only the first five cards to make a comparison with poker. If a bridge player's first five cards were to be the combination that constitutes a straight flush in poker, *he would probably not even be aware of it*, because in bridge, a "straight flush" has no value whatever. This combination of cards is not even defined in bridge, and

so I put quotation marks around the words "straight flush." Thus, we see that the *same combination of cards* is considered a wondrous combination in poker because of its rarity and value, but is considered a meaningless combination in bridge, *in spite of its rarity*, because it has *no value*.

4. The anthropic principle and the believing person

The preceding examples and discussion pave the way for an answer to our central question: What conclusions can one draw from the anthropic principle? The answer depends on one's views about the significance of human beings. In our example about poker and bridge, we explained why the extremely rare straight flush was a wondrous event in a poker game but a meaningless event in a bridge game. In other words, the *same rare event* can be either wondrous or meaningless; it all depends on the importance that one attributes to the event.

Returning to the subject of our essay, human beings, we saw that many extremely unlikely events ("a staggeringly improbable series of events...quite unrepeatable"²⁹) had to occur to make possible the appearance of human beings. Thus, the extreme rarity of the events leading to human existence is well established. Indeed, that is the scientific content of the anthropic principle. But before we can decide on the *meaning* of these events, we must first decide on the *meaning* of the end product: human beings.

If human beings are assumed to be just another species in the animal kingdom (as secularists believe), not more important than any other of the approximately two million species discovered so far, then the anthropic principle has no meaning. We have seen that rarity by itself is not significant. It is the straight flush in bridge, rare and interesting, but without meaning. If, however, one believes that human beings are the most important species in the world, and that mankind is the entire reason for the creation of the universe, as the Torah and the sages of the Talmud repeatedly emphasize, then the anthropic principle is of the utmost significance. It is the straight flush in poker, the most meaningful of occurrences.

In summary, scientists have discovered that in the existence of human beings, the universe has dealt out the extremely rare straight flush. Everyone agrees with this; the anthropic principle has become a scientifically established fact. But the nonbeliever is "playing bridge" and therefore the anthropic

principle means nothing to him. By contrast, the believing person is “playing poker,” and therefore the anthropic principle is yet another example of the harmony between modern science and words of the Torah.

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