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FANTASTIC VOYAGES

SECOND EDITION

Learning Science through
Science Fiction Films



Planet of the Apes

The film, *Planet of the Apes*, was one of the first to make extensive use of newly developed realistic makeup techniques so that humans could be cast in the parts of apes of the future. What a topsy-turvy world is depicted, at least from the human perspective. No longer are humans the dominant organisms; instead, it is the evolutionarily advanced descendants of present-day chimpanzees and other apes occupying the position that humans do in our contemporary world.

Is it totally far-fetched biologically to envision a distant future, e.g., the year 3978 when the film's story takes place, in which apes have taken over the place of humans? To examine this question, let us compare chimpanzees and humans and also examine some aspects of human evolution.

One method of comparing organisms is to compare their DNA. Organisms that belong to the same species have highly similar DNA. All members of the species must have a functional set of genes with information to direct their development and to conduct the functions of their bodies' cells. If genes are highly similar, as is true within a species, the DNA, which is normally present as double-stranded molecules, can be fragmented, separated into single strands, and then allowed to reform double strands spontaneously. The process is somewhat imperfect, but even so, for a given species, the DNA reforms into double strands very successfully. If one compares the amount of double-stranded formation when DNA of two species is mixed, one can ascertain how similar their DNA is. If the DNA is very similar, it will be very successful in forming double strands, even though it comes from different species. If it is very different, double strands will form poorly.

When human and chimpanzee DNA are compared, they are found to be amazingly similar. The estimates vary somewhat, but are always in the high nineties, 96% to 99%. This amount of similarity of the genetic material, itself, suggests that it would not take too much alteration to produce human characteristics in chimpanzees. It also demonstrates that the organization of the genes and the regulation of their expression is critical to the outcome of embryological development. Theoretically, there is no reason why chimps and humans could not have identical genes for the housekeeping functions of cells and for structural molecules, but differ in the developmental genes that control anatomic development.

In the classification of animals, humans and chimpanzees are both members of the class Mammalia, the order Primates, the suborder Anthroidea, and the superfamily Hominoidea. They belong to different families; humans, to the family Hominidae, and chimps, to the family Pongidae. Many of the evolutionary changes that were important for humans were changes that took place for the entire primate order and not for humans only. These include changes in the skeleton so that forelimbs functioned less and less in weight bearing, a shift from the sense of smell to the sense of vision as the primary source of information about the environment and conditions of the moment, development of a larger brain, and changes in behavior.

The development of a larger brain is especially important because it plays a role in the other changes. For example, without an enhanced ability to process and interpret visual information within the brain, the sense of vision could not have gained more importance among primates. If the brain had not changed to accommodate the altered use of body parts, the modified anatomies could not have made as much difference in the lifestyle of the involved species. Dr. Zira, herself a chimpanzee, explains in the film her theory about humans: that their brains are the source of their inability to speak and their limited manual dexterity.

Contemporary chimpanzees have a brain volume in the range of 280–400 cm³, whereas for humans it is about 1,300–1,400 cm³. Since the size of neural cells is similar for the two species, humans clearly have a much greater capacity for receiving and processing information and formulating and directing responses. Within the past 20 years, it was common to encounter statements asserting that much of the human brain is unused. However, the functions of areas previously thought devoid of functions have been discovered. Present thinking about the brain expects that all areas have functions; some remain to be discovered or clarified. Therefore, we cannot safely assume that humans simply have more unused brain volume than chimps. Humans must have more neural capacity through the intricate combinations of cells and their “wiring” patterns that determine the capabilities as well as the limitations of the species.

It may strike us initially as practically impossible for such changes to have occurred in the genetic information of both species without involving myriad alterations in genes. Were that the case, human evolution would be much more difficult to conceptualize. However, we can see a single developmental change occurring in the enlargement of the brain, one that would require very little alteration of genes. This change is called **neoteny**. Neoteny is, strictly speaking, the

return to a lesser stage of development after a more advanced stage has been achieved. A classic example is the amphibian *Ambystoma* which reforms the external gills it had during larval aquatic development at times when adults find conditions on the land untenable.

As it is applied to evolutionary changes, neoteny means that the development of a species tends to retain some juvenile or embryonic characteristics. In the case of human evolution, we can regard the development of a larger brain case (the cranium) and brain as a neotenic change. Juvenile humans have proportionately larger heads than do adults. Thus one way to enlarge the brain is to slow down development so that what was once a juvenile state becomes the end point of development, the adult state. If the genes that program human development changed so that the human head grew faster than the rest of the body, then the head would end up proportionately larger. Or if the genes were altered so that the other body parts grew more slowly, the same effect would be achieved.

Humans are the most extreme of the primates in the percentage of their lives spent in preadult stages as opposed to reproductive adult years. For humans about 18 years are preadult and about 32 years are reproductive adult years; that amounts to 36% preadult years. For chimpanzees about 12 years are preadult, and 28 years are reproductive adult years; that is 30% preadult years. For lemurs, it is about 4 years spent as a preadult, and 14 years as a reproductive adult; the lemurs spend only 22% of their lives as preadults. If we were to include the time of development in the uterus, the figures would be even more striking. These figures suggest that evolutionary neoteny has been a factor in the emerging differences seen among the primates.

Exercises

1. Practice thinking about how natural selection operates by describing how modern giraffes, which have long necks and feed on the leaves of trees, could have evolved from a population of ancestors with shorter necks. Try next to formulate a scenario in which chimpanzees could have evolved as depicted in *Planet of the Apes*. Use the information in this chapter, preceding chapters, and additional sources, if necessary.
2. A mass extinction of organisms, including the dinosaurs, occurred about 65 million years ago. One theory for how this extinction came about proposes that a giant asteroid crashed into the Earth and its impact raised a dust cloud that obliterated so much sunlight that plant growth was drastically diminished and resulted in the extinctions. Compare this kind of sudden alteration in the environment with that suggested in the film. Is it plausible for the catastrophe to have advanced the chimps and done the opposite to humans?
3. What human characteristics do you think are most important in supporting the human dominance of Earth? Defend your choices.
4. *Planet of the Apes* takes place in the year 3978 or roughly 2,000 years from the present. Is that amount of time long enough for humans and chimps to

have changed as depicted in the film? The first hominoids appear in the fossil record about 20–23 million years ago. About 6–10 million years ago the first hominids emerged. The earliest hominids belonged to the genus *Australopithecus*, which is now extinct. Modern humans arose around 300,000 years ago. In formulating your response, take into account also the experience of artificial selection by humans. The breeding of cattle was mentioned earlier. Other examples include the various breeds of domestic dogs and cats. Include an explanation of your rationale in your answer.

5. Chimpanzee's fingers are longer in proportion to their thumbs than are humans'. Is this difference likely to hinder chimps in attempting activities that humans perform easily? Make a list of 10 activities that require the use of your hands and evaluate whether they require precision or power. Do the same thing for chimpanzees.
6. Dr. Zaius says that he considers Taylor a mutant and expresses his concern that since one mutant has appeared, there are bound to be many others. Without considering whether or not he actually believes his statement, evaluate the likelihood of such a situation. Does evolution proceed with the generation of similar mutations? Could Taylor be, as he is called at one point, a "missing link"?
7. Explain what happened 2,000 years earlier in the Forbidden Zone. Why was the ancient taboo established?
8. What advanced capabilities have the apes attained in their culture? Which ones are missing?
9. Is it reasonable and probable that the events that changed humans and apes would have been regressive only for the humans and progressive for all of the various types of ape? Defend your answer.
10. Researchers trying to discover the similarities and limitations of chimpanzees, pygmy chimpanzees (bonobos), and other apes and monkeys find that their capabilities have been underestimated heretofore. In the book *Shadows of Forgotten Ancestors*, Carl Sagan and Ann Druyan recount the results of research that demonstrates among contemporary primates "friendship, altruism, love, fidelity, courage, intelligence, invention, curiosity, forethought, and a host of other characteristics" that are usually attributed especially, sometimes solely, to humans. They suggest that, "Perhaps our uniqueness is only this: an enhancement of well-established, preexisting talents for invention, forethought, language and general intelligence—enough to cross a threshold in our capacity to understand and change the world." What interpretations of the evolutionary events in *Planet of the Apes* become more probable if these findings are correct?
11. In humans the brain region that is comparatively much larger than that of an ape is the cerebrum. Using neoteny as a mechanism, explain what would happen to a chimp's brain during development to make it more like a human's.

Planet of the Apes

20th Century-Fox (US), 1968, color, 112 min.

Credits: Producer, Arthur P. Jacobs; director, Franklin J. Schaffner; screenplay, Michael Wilson and Rod Serling, based on the novel *Monkey Planet* by Pierre Boulle; music, Jerry Goldsmith.

Cast: Charlton Heston (George Taylor), Linda Harrison (Nova), Roddy McDowall (Dr. Cornelius), Kim Hunter (Dr. Zira), Maurice Evans (Dr. Zaius), James Whit-

more (President of the Assembly), James Daley (Honorious), and Robert Gunner (Landon).

Plot Summary

The film opens with astronaut George Taylor completing his final report before returning to Earth. While he and his crew have aged only six months, their ship's computer indicates that 700 years have elapsed on Earth because the ship was traveling at nearly the speed of light. At the conclusion of his message, Taylor gives himself an injection and straps himself into a sleep chamber like those occupied by the other three astronauts.

The spaceship lands on an unknown planet, in an area that resembles the Grand Canyon. The sleep chambers open, and three of the four astronauts emerge. The fourth astronaut, the only woman in the group, has died of old age because of an air leak. The ship's computer indicates that the year is now 3978 on Earth.

The three astronauts escape on a lifeboat as water floods the cabin of the spaceship. As they approach the shore, the spaceship sinks. After some discussion, they conclude that they do not know where they are. All they have been able to carry from the spaceship is a soil test kit, medical supplies, and enough food for a few days.

They explore the area for food and civilization, but encounter only a dangerous avalanche. By this time they have only 8 oz of water, and there is no sign of rain, although they see lightning and hear thunder. Suddenly, they discover life—a plant with bright yellow flowers. Their hope renewed, the men continue



Planet of the Apes. George Taylor is held captive with other humans by a race of intelligent apes. (Photo: Museum of Modern Art/Film Stills Archive. Courtesy of 20th Century-Fox.)

searching through the night and on the following day they notice people looking at them from atop a hill. These “people” turn out to be scarecrows made to resemble people. Beyond the hill they find a waterfall. They bathe and drink, but when they return for their clothes they find that most of them are missing. In the distance they see a tribe of primitive people. It appears that these people are unable to speak. When the tribe sees the astronauts, they panic and scatter.

Suddenly, gunshots are fired by horsemen. The astronauts are shocked when they realize that the gunmen are actually human-size *apes*. The apes beat and capture many of the humans. In the process one of the astronauts is mistaken for a primitive human and is killed by the apes. Taylor, shot in the throat, is captured along with the third astronaut. Taylor is surprised to see the apes taking pictures of themselves with their human kills, and to hear the apes speaking English. Taylor is placed in a cell in a research institute. Later a young woman is also put into Taylor’s cell. He calls her “Nova.”

He surmises that evolution has taken a different course on this planet. Humans cannot talk. They can be taught a few tricks but are basically wild and untamed. The apes regard humans as a nuisance. Dr Zaius, the simian Minister of Science observes to his colleagues that human scavengers ravage their crops and the sooner they are exterminated, the better.

Zaius’ hatred is prompted by an ulterior motive: he has secretly discovered that humans once ruled their planet. This fact is at odds with ape history as expounded in the Simian Bible, called the Twelve Scrolls. If the truth were known, the foundation of ape culture would be undermined. Zaius, who is also Defender of the Faith, feels obliged to suppress this information.

Dr. Zira, a researcher, and her fiance, Dr. Cornelius, an archaeologist, discover that Taylor is different from other humans. Because of his gunshot wound, Taylor temporarily cannot talk, but he demonstrates his ability to understand Zira by writing in the sand and then by handing her a note stating that his name is “Taylor.” Taylor tells Cornelius and Zira that his spaceship landed in an uninhabited area which the apes refer to as the Forbidden Zone. Cornelius is excited because he has unearthed evidence of an older human civilization in this area. He has not been able to convince anyone, but Taylor appears to be a living example of his discovery.

When Zaius learns of Taylor’s verbal abilities, he puts him on trial to dispose of him and threatens to accuse Zira and Cornelius of scientific heresy if they aid in Taylor’s defense. In the course of the trial Taylor discovers that a lobotomy has been performed on the third astronaut to prevent him from also demonstrating the ability of speech. Secretly Zira and Cornelius help Taylor to flee to the excavation site. When Zaius goes there, he is confronted by one of their findings—the remains of a talking doll from an older civilization of humans. Zaius still will not concede. He asks, “Why, if man were superior, did he not survive?” No one can answer that question.

The question is answered when Taylor and Nova win their freedom and ride off on horseback along the deserted shore. Ahead, Taylor sees a massive structure which turns out to be the Statue of Liberty, now almost completely covered by

sand. He now realizes that his journey has taken him forward in time to the Earth. In a rage, he yells, “You finally did it! You murderers! You blew it up!”