Pyramids
(Edited from Wikipedia)

EGYPTIAN MYTHOLOGY

Pyramids are religious monuments. The pyramid’s shape represented the religious beliefs of ancient Egyptian culture. Their religious beliefs are found in old myths.

Myths appear frequently in Egyptian writings and art, particularly in short stories and in religious material such as hymns, ritual texts, funerary texts, and temple decoration.

Inspired by the cycles of nature (like the passing of the seasons, the daily rise of the sun and moon, life and death, and so on), the Egyptians saw time in the present as a series of recurring patterns. Myths told stories about what happened in the beginning. Then, history and life consists of living through these cycles, continually repeating the events of the myth. This is supposed to renew Ma’at, which is the Egyptian word for the fundamental order of the universe.

Among the most important stories from the mythic past in ancient Egyptian culture are the creation myths, in which the gods form the universe out of primordial chaos and the stories of the reign of the sun god Ra upon the earth.

Recurring themes in these myths include the conflict between the upholders of order and the forces of disorder, the importance of the pharaoh in maintaining order, and the continual death and regeneration of the gods.

Mythology profoundly influenced Egyptian culture. It inspired or influenced many religious rituals and provided the ideological basis for kingship. Scenes and symbols from myths appeared in art in tombs, temples, and amulets. In literature, myths or elements of them were used in stories that range from humor to allegory, demonstrating that the Egyptians adapted mythology to serve a wide variety of purposes.

Creation Myths

Among the most important myths were those describing the creation of the world. The Egyptians developed many accounts of the creation, which differ greatly in the events they describe. One common feature of the myths, though, is the emergence of the world from the waters of chaos that surround it.
Benben was the mountain of earth that arose from these chaotic waters, which were called Nu. The Benben stone, named after the mountain, was a sacred stone in the temple of Ra. It was the location on which the first rays of the sun fell each day. In ancient Egypt, these were probably gilded, or coated with gold, so they shone in sunlight.

Cosmology

The Egyptian conception of the universe centered on Ma'at, a word that encompasses several concepts in English, including "truth," "justice," and "order."

In Egyptian belief, Ma'at was constantly under threat from the forces of disorder, so all of society was required to maintain it. Chaos could come crashing in at any time.

On the human level this meant that all members of society should work together to prevent this from happening; on the cosmic level it meant that all of the forces of nature—the gods—should continue to function in balance. This latter goal was central to Egyptian religion. The Egyptians sought to maintain order in the cosmos by sustaining the gods through offerings and by performing rituals which staved off disorder and kept nature and the seasons going.

Kingship was a key element of Egyptian religion. The king was a link between humanity and the gods.

The pyramid represented the social order. The king, or pharaoh, was at the top. He was the most evolved human. He was almost a god. He communicated with the gods. Beneath him was the rest of civilization. It was like a rigid military hierarchy. At the very bottom were the slaves. The number of slaves outnumbered the elite rulers up the chain.

That is why the pyramid is the shape it is. The king was at the top of the social order. There was only one king. The slaves were at the bottom supporting the king.

THE AFTERLIFE

Egyptians conceived of an afterlife as quite similar to normal physical existence — but with a difference. The model for this new existence was the journey of the Sun. At night the Sun descended into the underworld. Eventually the Sun meets the body of the mummified Osiris. Osiris and the Sun, re-energized by each other, rise to new life for another day.

The soul had to avoid a variety of supernatural dangers in the underworld, before undergoing a final judgment known as the "Weighing of the Heart". In this judgment,
the gods compared the actions of the deceased while alive to determine whether he or she had behaved correctly. Often the dead were said to dwell in the realm of Osiris, a lush and pleasant land in the underworld.

*The Book of the Dead* was a collection of spells which aided a person in the afterlife. They helped people avoid the perils of the afterlife and also aided their existence, containing spells that helped them not die in the afterlife. In the Egyptian religion it was possible to die in the afterlife, and this death was permanent.

**PYRAMIDS**

A pyramid is a structure whose outer surfaces are triangular and converge to a single point at the top, making the shape roughly a pyramid in the geometric sense. The base of a pyramid can be trilateral, quadrilateral, or any polygon shape, meaning that a pyramid has at least three outer triangular surfaces (at least four faces including the base). The square pyramid, with square base and four triangular outer surfaces, is a common version.

A pyramid’s design allowed early civilizations to create stable monumental structures.

A benben stone is the uppermost piece or capstone of an Egyptian pyramid. They were generally made of stone, then covered in gold to reflect the rays of the sun. They were also often inscribed with royal titles and religious symbols.

Pyramids have been built by civilizations in many parts of the world. For thousands of years, the largest structures on Earth were pyramids—first the Red Pyramid in the Dashur Necropolis and then the Great Pyramid of Khufu, both of Egypt. The Great Pyramid is the only one of the Seven Wonders of the Ancient World still remaining. Khufu’s Pyramid is built mainly of limestone (with large red granite blocks used in some interior chambers), and is considered an architectural masterpiece. It is still the tallest pyramid.

**THE GREAT PYRAMID**

It is believed the pyramid was built as a tomb for Fourth Dynasty Egyptian pharaoh Khufu (sometimes written as "Cheops") and was constructed over a 20-year period. Its present height is 455.4 feet.

Based on estimates, building the pyramid in 20 years would involve installing approximately 800 tonnes of stone every day.

[Note: a “tonne” is a metric ton equal to 2,204.6 pounds.]
Additionally, since it consists of an estimated 2.3 million blocks, completing the building in 20 years would involve moving an average of more than 12 of the blocks into place each hour, day and night.

The first precision measurements of the pyramid were made by Egyptologist Sir Flinders Petrie in 1880–82 and published as *The Pyramids and Temples of Gizeh*. Almost all reports are based on his measurements. Many of the casing stones and inner chamber blocks of the Great Pyramid fit together with extremely high precision. Based on measurements taken on the northeastern casing stones, the mean opening of the joints is only 0.5 millimeter wide (1/50 of an inch).

The accuracy of the pyramid's workmanship is such that the four sides of the base have an average error of only 58 millimeters in length. The base is horizontal and flat to within ±15 mm (0.6 in).

The sides of the square base are closely aligned to the four cardinal compass points based on true north, not magnetic north, and the finished base was squared to a very small error.

The completed design dimensions, as suggested by Petrie's survey and subsequent studies, are estimated to have originally been 280 royal cubits high by 440 cubits long at each of the four sides of its base. The perimeter is the total length of each side. Since the base is a square, and each side was 440 cubits long, then the perimeter is 4 x 440, which equals 1,760 cubits.

The ratio of the perimeter to height of 1760 divided by 280 royal cubits equates to 2\pi.

Some Egyptologists consider this to have been the result of deliberate design proportion.

Others have argued that the Ancient Egyptians had no concept of “pi” and would not have thought to encode it in their monuments. They believe that the observed pyramid slope may be based on a simple slope choice alone, with no regard to the overall size and proportions of the finished building.

**CONSTRUCTION MATERIALS**

The Great Pyramid consists of an estimated 2.3 million blocks which most believe to have been transported from nearby quarries. The limestone used for the casing was quarried across the river. The largest granite stones in the pyramid, found in the "King's" chamber, weigh 25 to 80 tonnes and were transported from more than 500 miles away.
Traditionally, ancient Egyptians cut stone blocks by hammering into them some wooden wedges, which were then soaked with water. As the water was absorbed, the wedges expanded, causing the rock to crack.

Once they were cut, they were carried by boat either up or down the Nile River to the pyramid. It is estimated that 5.5 million tonnes of limestone, 8,000 tonnes of granite (imported from Aswan), and 500,000 tonnes of mortar were used in the construction of the Great Pyramid.

At completion, the Great Pyramid was surfaced by white "casing stones" – slant-faced, but flat-topped, blocks of highly polished white limestone. These were carefully cut to what is approximately a face slope. Visibly, all that remains is the underlying stepped core structure seen today.

In AD 1303, a massive earthquake loosened many of the outer casing stones, which were then carted away in 1356 to build mosques and fortresses in nearby Cairo. Many more casing stones were removed from the great pyramids by Muhammad Ali Pasha in the early 19th century to build the upper portion of his Alabaster Mosque in Cairo not far from Giza. These limestone casings can still be seen as parts of these structures.

Later explorers reported massive piles of rubble at the base of the pyramids left over from the continuing collapse of the casing stones, which were subsequently cleared away during continuing excavations of the site. Nevertheless, a few of the casing stones from the lowest course can be seen to this day around the base of the Great Pyramid, and display the same workmanship and precision that has been reported for centuries.

CONSTRUCTION THEORIES

There have been many hypotheses about the Egyptian pyramid construction techniques. These techniques seem to have developed over time; later pyramids were not built the same way as earlier ones. Most of the construction hypotheses are based on the idea that huge stones were carved with copper chisels from stone quarries, and these blocks were then dragged and lifted into position. Disagreements chiefly concern the methods used to move and place the stones.

[The main thing to note here: there’s no agreement on how the pyramids were built. The stones are huge. We don’t understand how the tools we think were available to the Egyptians at the time could have been used to move them.]

In addition to the many unresolved arguments about the construction techniques, there have been disagreements as to the kind of workforce used. The Greeks, many years after the event, believed that the pyramids must have been built by slave labor.
Archaeologists now believe that the Great Pyramid of Giza (at least) was built by tens of thousands of skilled workers who camped near the pyramids and worked for a salary or as a form of tax payment until the construction was completed. They point to workers' cemeteries discovered in 1990.

During the earliest period, pyramids were constructed wholly of stone. Locally quarried limestone was the material of choice for the main body of these pyramids, while a higher quality of limestone quarried at Tura (near modern Cairo) was used as the outer casing. Granite was used to construct some architectural elements, including the gate and the roofs and walls of the burial chamber.

One of the major problems faced by the early pyramid builders was the need to move huge quantities of stone. The tomb of one pharaoh has an illustration of 172 men pulling a statue of him on a sledge. The statue is estimated to weigh 60 tons and with estimates that 45 workers would be required to start moving a 16,300 kg lubricated block, or eight workers to move a 2,750 kg block.

A possible method for rolling the stones is using a cradle-like machine that had been excavated in various temples. Four of those objects could be fitted around a block so it could be rolled easily. Experiments done showed how 18 men could drag the block over a 1-in-4 incline ramp, at a rate of 18 meters per minute.

It is still not known whether the Egyptians used this method but the experiments indicate it could have worked using stones of this size. Egyptologists generally accept this for the smaller blocks mostly used but do not agree over the methods used for the much larger blocks.

As the stones forming the core of the pyramids were roughly cut, especially in the Great Pyramid, the material used to fill the gaps was another problem. To make the mortar, it had to be dehydrated by heating which requires large quantities of wood. According to Egyptologists, findings may suggest that Egypt had to strip its forest and scrap every bit of wood it had to build the pyramids of Giza and other even earlier 4th Dynasty pyramids.

Workmen probably used copper chisels, drills, and saws to cut softer stone, such as most of the limestone. The harder stones, such as granite, cannot be cut with copper tools alone; instead they were worked with time-consuming methods like drilling and sawing with the aid of an abrasive, such as quartz sand. Blocks were transported by sledge likely lubricated by water. Leveling the foundation may have been accomplished by use of water-filled trenches or through the use of a crude square level and experienced surveyors.
The Greek writings of Herodotus and Diodorus Siculus

The unknowns of pyramid construction chiefly center on the question of how the blocks were moved up the pyramid. There is no known accurate historical or archaeological evidence that definitively resolves the question. Therefore, most discussion on construction methods involves functional possibilities that are supported by limited historical and archaeological evidence.

Historical accounts for the construction of the Egyptian pyramids do little to point definitively to methods to lift the blocks; yet most Egyptologists refer to these accounts when discussing this portion of pyramid construction.

The first historical accounts of the construction of these monuments came centuries after the era of pyramid construction, by Herodotus in the 5th century BC and Diodorus Siculus in the 1st century BC. Herodotus's account states:

This pyramid was made like stairs, which some call steps and others, tiers. When this, its first form, was completed, the workmen used short wooden logs as levers to raise the rest of the stones; they heaved up the blocks from the ground onto the first tier of steps; when the stone had been raised, it was set on another lever that stood on the first tier, and the lever again used to lift it from this tier to the next. It may be that there was a new lever on each tier of steps, or perhaps there was only one lever, quite portable, which they carried up to each tier in turn; I leave this uncertain, as both possibilities were mentioned. But this is certain, that the upper part of the pyramid was finished off first, then the next below it, and last of all the base and the lowest part.

Diodorus Siculus's account states:

And 'tis said the stone was transported a great distance from Arabia, and that the edifices were raised by means of earthen ramps, since machines for lifting had not yet been invented in those days; and most surprising it is, that although such large structures were raised in an area surrounded by sand, no trace remains of either ramps or the dressing of the stones, so that it seems not the result of the patient labor of men, but rather as if the whole complex were set down entire upon the surrounding sand by some god. Now Egyptians try to make a marvel of these things, alleging that the ramps were made of salt and natron and that, when the river was turned against them, it melted them clean away and obliterated their every trace without the use of human labor. But in truth, it most certainly was not done this way! Rather, the same multitude of workmen who raised the mounds returned the entire mass again to its original place; for they
say that three hundred and sixty thousand men were constantly employed in the prosecution of their work, yet the entire edifice was hardly finished at the end of twenty years.

Diodorus Siculus's description of the shipment of the stone from Arabia is correct since the term "Arabia" those days implied the land between the Nile and the Red Sea where the limestone blocks have been transported from quarries across the river Nile.

Most Egyptologists acknowledge that ramps are the most tenable of the methods to raise the blocks, yet they acknowledge that it is an incomplete method that must be supplemented by another device. Archaeological evidence for the use of ramps has been found at the Great Pyramid of Giza and other pyramids.

The method most accepted for assisting ramps is levering – pushing the blocks up the ramps with levers. The archaeological record gives evidence of only small ramps and inclined causeways, not something that could have been used to construct even a majority of the monument. There is other evidence which creates even more uncertainty.

Therefore, there are many proposed ramps and there is a considerable amount of discrepancy regarding what type of ramp was used to build the pyramids. One of the widely discredited ramping methods is the large straight ramp, and it is routinely discredited on functional grounds for its massive size, lack of archaeological evidence, huge labor cost, and other problems.

Other ramps serve to correct these problems of ramp size, yet either run into critiques of functionality and limited archaeological evidence. There are zig-zagging ramps, straight ramps utilizing the incomplete part of the superstructure, spiraling ramps supported by the superstructure and spiraling ramps leaning on the monument as a large accretion are proposed.

One person speculated that a spiraling ramp, beginning in the stone quarry to the southeast and continuing around the exterior of the pyramid, may have been used. The stone blocks may have been drawn on sleds along the ramps lubricated by water or milk.

Levering methods are considered to be the most tenable solution to complement ramping methods, partially due to Herodotus's description; and partially to the Shadoof; an irrigation device first depicted in Egypt, and found at the same time in Mesopotamia.

Levers should be employed to lift a small amount of material and over great deal of vertical height of the monument.