CHAPTER 2

The Emerging Human Pattern

HUMANS — from the tips of their fingernails to their facial proportions — have been shaped by the ways they acquire and utilize food. The exact details of how humans gradually developed into omnivorous animals with a wide range of cultural associations between eating and social behavior, symbols, status, and sexual relations can never be known for certain. A surprising number of facts about the origins of the human diet can, though, be inferred from observing our living primate relatives among the apes and monkeys, from fossils, and from surviving hunter–gatherer societies. A number of biological and behavioral features that are the foundation for the way humans eat were inherited from the primates, whose living species display them in rudimentary form: adaptability in foraging, the occasional sharing of food, and clear preferences for certain foods and ways of obtaining them. The physical structures inherited by humans from primate ancestors include mobility of the digits, a reduction in the size of the snout and the teeth, and stereoscopic vision.

Most apes and monkeys are adapted to a diet of plant foods, and some — such as the colobus and howler monkeys, and the gorilla — even have specialized digestive tracts whose lengthened intestines can cope with the leaves that are indigestible for almost all other mammals. Many other primates are more omnivorous, and some feed on a wide variety of roots, seeds, fruits, flower buds, nuts, and such animal foods as insects, bird eggs, reptiles, even other primates. In zoos, almost all primates easily adapt to a diet of chow and offal, along with the peanuts and ice cream offered by visitors. Despite the basic orientation of apes and monkeys toward plant food, the need for vitamin B_{12} means that they must eat some food of animal origin to survive — as they all do, either

intentionally or unwittingly, in the form of insects that are consumed along with the plants they feed on.

The direction to be taken by human feeding behavior was foreshadowed when, perhaps seventy million years ago, ancestral primates became adapted to an arboreal environment. There they were able to exploit a nutritional wealth of fruits, nuts, and seeds — as well as insects — that had not previously been tapped to any great extent by mammals. As a way of locating this new food source, the primates evolved refinements in vision: The stereoscopic placement of the eyes and the ability to discriminate colors were advantageous because at a distance it is of course easier to see a banana than to smell it. Other adaptations were equally necessary for success at exploiting the new niche in the trees. For example, the hand developed as an organ of manipulation, which meant that the mouth no longer had to be used for investigating and seizing what the eyes had detected, but was liberated to develop the rich vocal communication of the nonhuman primates and eventually the symbolic language of humans.

The human ability to make tools would have been impossible had not the primate ancestors evolved fingers of great dexterity, bearing nails instead of claws. Unlike squirrels and other arboreal mammals that climb by digging their claws into the bark, primates climb by grasping, an efficient way of moving about in search of new food sources that did not interfere with the manipulative ability of sensitive fingertips. A lessened emphasis on smell, the preeminent sense in almost all other mammals, had important consequences for human evolution. Sight became paramount; the mammalian snout was nearly eliminated, thereby bringing the eyes forward to a position that not only made stereoscopic vision possible but also afforded a better view of the ground while walking upright. The disappearance of the snout further allowed the lips a new mobility, widening the possible range of facial expressions.

Language, upright posture, tool-making, a large brain — these and other hallmarks of the human species can be traced back in one way or another to the primate adaptation to food sources in the trees. Upright posture probably developed as much in response to the need to carry food as it did to the need to use the hands in making and using tools; and once humans were on their hind legs, the hands were freed to evolve into the marvelous

organs of manipulation they now are. The very shape of the human head is a result of evolutionary changes associated with eating: The jaws and the teeth became smaller, as did the brow ridges of the skull, once buttresses for powerful chewing muscles were no longer essential; and an increasingly large brain gave humans a superior ability to process information, much of it originally having to do with the availability of food and the best ways to obtain it.

All of the categories of foods that humans find edible are also consumed by primates in the wild, except for the milk of domesticated mammals, certain spices, and cola and caffeine beverages. Like humans, but unlike most other mammals, primates are selective in that they show clear preferences not only for specific foods but also for specific parts of these. The gorillas of Central Africa, for example, at various times of the year will feed on a hundred or more species of plants that grow there; yet the bulk of their nourishment is derived from the few species they prefer to eat. Despite such preferences, nonhuman primates maintain their flexibility in choosing foods, which indicates that the evolutionary basis for food choice in humans was not completely ordained by the genes. The ancestors of certain baboons were forest-dwelling monkeys that moved onto the tree-dotted savanna — an ecological shift that was also made, at least five million years ago, by the ancestors of humans. Although ninety percent of the diet of the olive baboon is grass, it has also been known to eat flowers, vines, lizards, insects, immature birds, and small mammals — a flexibility indicating that nonhuman primates, like humans, have been able to take advantage of changing opportunities offered by the environment.

At least some animal food is consumed by virtually all primate species. In fact, certain monkeys and prosimians (the tarsiers, lemurs, lorises, and other relatively primitive species that still survive in Africa and Madagascar) apparently consume more worms, insects, frogs, lizards, and bird eggs than they do plant foods. The actual proportion of animal to plant food is less important than that primates have probably always been able to obtain and to digest animal foods. Apes and monkeys were not under any evolutionary pressure toward a more largely carnivorous diet, for the reason simply that the forests contained a diverse and nearly unlimited supply of plant foods. Even so, chimpanzees and baboons

cooperatively seek out and pursue animal prey, such as other primates or young grazing mammals. During a recent twelve-year period, about 170 examples of hunting by chimpanzees were recorded by primatologists at Tanzania's Gombe National Park, and undoubtedly numerous other hunts took place unobserved.

Most primate species that were once considered herbivorous are now known to expand the proportion of animal foods in their diet to levels as high as ninety percent at times when insects are abundant and can be easily captured. This was dramatically seen in the behavior of several groups of baboons in Botswana several years ago, when an explosive increase in the numbers of insects on certain kinds of trees occurred. Baboons in the vicinity during this period immediately switched from their usual diet, consisting largely of plants, and devoted seventy-two percent of their foraging time to capturing insects.

The repugnance of modern North Americans and Europeans toward the eating of insects obscures the large proportion of protein they must have supplied for early humans, and still supply for some American Indians and groups in Africa and the Near East. Grasshoppers and other members of the locust family, for example, are an exceptionally nutritious food. Merely a handful provides the daily allowance of vitamin A, as well as protein, carbohydrate, and fat. In addition to locusts, early humans must also have consumed, as hunter–gatherers still do today, beetle grubs, caterpillars, bee larvae, termites, ants, cicadas, and aquatic insects. An analysis of the fried termites eaten in West Africa has shown that they contain about forty-five percent protein, a higher proportion even than in dried fish.

Given such nutritional benefits, the repugnance toward insects as food in modern societies is difficult to understand, as is the eagerness to eat other kinds of invertebrates: clams, mussels, oysters, snails, squid, and especially the lobsters, crabs, and shrimp that are more closely related to insects. The distinction between invertebrates that are eaten and those that are not seems to hinge on whether they live in water; living in the sea apparently removes a species from everyday associations. People in Florida, for example, eat crabs from the sea readily enough, yet they disdain land crabs, which are closely related and equally tasty. The avoidance by people in Western societies of grasshoppers and locusts is especially mystifying. Even though these were specifically recom-

mended to the Israelites in the dietary laws of Leviticus, one of the books of Moses, modern-day Jews avoid them. And although John the Baptist, according to Matthew (3:4), lived in the wilderness of Judea on "locusts and wild honey," modern Christians avoid them also.

The human tendency to switch to animal foods whenever these become available is apparently a legacy from primate ancestors. But the preference for meat on the part of early humans could be indulged only to a limited degree in the absence of sophisticated tools and weapons, of domesticated animals, and of the long-distance transportation that today makes meat available in quantity to large numbers of humans. Nowadays, though, with meat readily available, the preference for it has become hazardous to health. Animal products are now consumed regularly in quantities that earlier in evolution were achieved only irregularly.

Anthropologists used to assume that in the evolution of human behavior, once erect posture left the hands free to use weapons and other tools, the early humans could become hunters of game in the open country into which they had moved from the forests. According to this hypothesis, cooperative hunting eventually led to the sharing of food within some kind of family structure. Since it is now known that apes and monkeys cooperate in the hunt and in sharing the kill afterwards, this behavior may actually have evolved millions of years before the advent of "ape–men." Hunting by humans, though, differs from that of apes and monkeys in two major ways. Humans communicate through speech, which makes possible strategies more complex than those of any kind of nonhuman primate. And whereas nonhuman primates could kill only small animals, humans developed weapons and complex systems of cooperation that enabled them to bring down prey much larger than themselves.

When human ancestors left the forest cradle of the primates to walk upright on the African plains, perhaps five million years ago, they apparently became increasingly carnivorous in contrast to the apes and monkeys. Humans retain the long gut of a herbivore and the sweet tooth of fruit-eating primate ancestors, but human teeth suggest those of a carnivore; and the fact that in virtually every human society animal foods are the most desired, even though they are usually the most difficult to obtain, is another sign of the carnivorous heritage of humans. But just as the

basically plant diet of apes and monkeys became the more carnivorous diet of early humans, a return to an emphasis upon plants for food occurred with the invention of agriculture in various parts of the world some ten thousand years ago. Rice and wheat alone account for more than forty percent of the foods, whether plant or animal, eaten in the world today. Agriculture has meant, in fact, a great decrease in the variety of foods eaten. Whereas tens of thousands of plant species are known to be edible, only about six hundred of these are cultivated, and virtually no plants of importance for food have been added to the list of domesticated species for thousands of years.

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Although humans share many features with the nonhuman primates, the differences between the behavior of the humans' closest relatives, the chimpanzees, and even the simplest hunting–gathering society are enormous — and most of these differences stem from contrasts in their quest for food. Humans carry food from place to place, either inside containers or suspended from poles, and once the food is back at the settlement, they regularly share it according to established rules and customs; they exchange recipes, and culinary techniques are passed from generation to generation. No chimpanzee or any other primate even approaches these practices. And whereas roughly seventy percent of an ape's time each day is devoted to finding food, hunters and gatherers need spend only a few hours a day.

For more than ninety-nine percent of its history, down to the beginnings of agriculture, the human species sustained itself by hunting and gathering. This cultural adaptation is based on two facts: First, some sort of plant food is always available, regardless of the season or the weather, thus becoming the mainstay of the diet; second, game animals provide certain essential nutrients, but they represent a smaller proportion of the food consumed because they are not always available or because hunting has been unsuccessful. From these two facts, several conditions of hunter–gatherer life necessarily follow: a willingness to cooperate in the quest for food, to share afterwards, and a submission to the rules that assign tasks according to sex — the hunting of large animals by males, the gathering of plants, insects, and other small animals by females. Perhaps 300,000 human beings around the world still

follow the hunting–gathering way of life, some in the northern tundras, others in the deserts of Australia and southern Africa, in the rain forests of Africa, and in parts of South America and Southeast Asia. Vestiges of hunting–gathering ways may be seen in the behavior of modern humans. A roast is ritually butchered at the dinner table by the senior male in the household, wielding a weapon larger than a carving knife need be, and by the practice of leaving on the head of the pig, pheasant, or fish that is about to be eaten — occasionally with an edible object such as an apple in its mouth, as though it had been killed in the very act of feeding.

The overriding importance in human evolution of cooperative hunting and sharing is indicated by archeological excavations at several sites in East Africa. These, dating back to between two and three million years ago, have provided unambiguous evidence that large mammals were hunted successfully, butchered on the spot, and carried back in pieces to camps. Hunter–gatherers of course cannot preserve meat except by drying small strips of it in the sun (as jerky) or, as the Eskimo and other Arctic people do, by freezing it. The efficiency of the natural deep-freezer of northern climates was shown by the discovery in Siberia of mammoths that had died about fifty thousand years ago — and that were so well preserved in the ice that steaks were cut from them by the explorers who made the discovery.

The transportation of food back to the camp means that the early humans, unlike apes and monkeys, postponed food consumption — which made possible the success of the hunting–gathering adaptation, because transportation implies a camp that everyone agrees to return to, the division of labor in the tasks relating to food, and the sharing of the foods obtained. When several families come together in one camp, they engage in endless exchange of information typical of human activity: that nuts in a certain grove two miles to the east are ripe, or that a hunter has crossed the spoor of a large animal. They can become much more efficient in the quest for food through dividing tasks according to sex and age — the women to gather, the men to hunt, the young and the elderly to take care of things around the camp. The division of labor not only brings in much more food, but it also makes possible a greater variety, which means in turn a balanced diet for everyone. The exchange and sharing of food mean that the one

who gives today can expect to receive tomorrow. And from that expectation stem reciprocal obligations, rules to enforce fair sharing, and marital ties between kin groups to make sharing permanent. The human family probably could not have arisen without those early and simple steps toward the sharing of food.

In this hypothetical reconstruction, hunting by males is not the central event. That it was so, and for so long, in the minds of anthropologists, came about largely because few archeological remains of plant-gathering have been unearthed. The wooden stick used by women for digging out roots and tubers would have decayed, whereas the man's stone hunting points and butchering tools would have been preserved. Likewise, the bones of food animals are more likely to be fossilized than are roots or berries. Two facts, though, indicate how important the female role of plant gatherer must have been: The patterns of wear on the fossil teeth of early humans show that plant food was consumed in quantity, and statistical studies of present-day hunter–gatherers reveal that on an average two-thirds of their food supply consists of plants. The drama of males hunting dangerous game long obscured for anthropologists the less dramatic, but much more important, aspect of the hunting–gathering adaptation: the fact that males and females agree to return to a common meeting place to share what they obtained in the quest for food.

Hunting–gathering societies have various rules about sharing meat. In the case of the San (sometimes referred to as Bushmen) of the Kalahari Desert of southern Africa, the owner of the arrow that made the kill gets the choicest parts; the next in line is the hunter who first sighted the game, followed by the one who threw the first spear, and so on until each man in the hunting party has received a share. If the kill is a large animal, each hunter then divides his portion with relatives, who in turn distribute what they have received to others. This means that when an animal the size of a giraffe has been killed, virtually everyone in several neighboring camps will have received some of the meat through a process that spreads outward like ripples through water. The consumption of huge amounts of meat whenever it becomes available survives today in the human species as the so-called "hunter's appetite": People still eat as though in anticipation of a shortage of meat even though none is imminent. Plant foods, which are shared by women with their children, their husbands, and

very close relatives, usually do not go beyond the immediate household, simply because any family will be able to find plants for itself.

Among the Copper Eskimo of central Canada, each hunter goes into partnership with a large number of others for the reciprocal sharing of the ringed seals they kill. Each seal is divided into fourteen agreed-upon cuts, six of which (including the two front flippers, the two rear flippers, and the shoulders) consist of pairs, thus providing portions for a total of nineteen partners besides the hunter himself. When a successful hunter returns with a seal on his sled, the wives and children of his partners wait patiently while the animal is dismembered. Each then speaks the partner's name, whereupon the hunter's wife offers the stomach, the liver, the front left flipper, or whatever. The event has become institutionalized under the name *nippiqtuq,* meaning "he waits to get his share" — and each of the partners is called by a name corresponding to the portion of the seal to which he is entitled: "Stomach-Meat-Companion," "Neck-Companion," "Liver-Companion," and so on.

It might seem that the hunter who made the kill in the first place should have a claim to all or most of it. But the reputation of those who freely distribute meat is enhanced both for skill in hunting and for generosity as members of their society. The presence of even a few very successful hunters in a camp often draws families from other camps; these hunters are also able to attract the most desirable females; and they are listened to when important decisions must be made. The successful hunter who shares generously places an increasing number of people in his own band, and in neighboring bands as well, under obligation to him. He thereby adds to his own prestige, and he also gains the power of a creditor — one to whom others must reciprocate by sharing meat when they are successful in the hunt. The gathering of plant foods does not give women the same prestige, even though at certain times of the year they may have provided eighty percent of a band's food supply. Plants simply do not have the prestige that meat does, presumably because a man can always go out and pick some berries or nuts, whereas a woman cannot suddenly decide to go hunting.

Why should males be the hunters and females the gatherers? Males tend to be somewhat stronger and more aggressive than

females, but that cannot be the entire answer because in any band of foragers at least some of the females are every bit as qualified physically as some of the males for hunting. The reason appears to be the need to travel light on the hunt because any burden would interfere with the hunter's ability to chase game over long distances; it would throw off the balance and coordination needed to hurl a spear or to shoot an arrow. In this females are handicapped because of the burdens they must carry — the fetus during pregnancy, and the nursing infant for at least two years (no other source of milk or other infant food being available to hunter–gatherers). Since the periods during the life span of an adult female when she is not either pregnant or nursing are relatively short and sporadic, a small band would be squandering its human resources if women were trained in the many skills needed for hunting. Much greater survival value attaches to training them from childhood in the far different skills needed for gathering — identifying an underground tuber by its stem or knowing when the fruit of a certain tree will be ripe.

Numerous new sharing relationships are created whenever two people in a hunting–gathering society marry, as new roles are assumed by each member of the two united families. The new husband becomes a son-in-law to the bride's parents and a brother-in-law to her brothers and sisters, and in such ways the network of kin from whom food can be received and to whom it will be distributed is enlarged, thereby reducing the risk of hunger for any one of them. Even the unrelated members of the society benefit from a marriage because it forges alliances between kin groups and between bands, further enlarging the network of sharers and reducing the likelihood that anyone will be in want. Early in human evolution, the subsistence bond between a male hunter and a female gatherer must have provided an important basis for stability in the band. Each partner to a marriage might have managed to dispense with the other for sex, for companionship, or for protection — but not for the exchange of plant and animal foods.

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Since humans, bears, and pigs consume basically the same sort of omnivorous diet, the teeth of all three show many similarities even though they evolved along very different paths. In fact, the

fossilized teeth of a pig unearthed in Nebraska were once mistaken by biologists for those of an early human — an indication of the obvious fact that the food an animal eats largely determines the number, kinds, and shapes of teeth it has. Omnivorous mammals, including humans and some other primates, depart little from the basic mammalian pattern of dentition; they lack such specializations as the enormous front teeth used by horses for cropping grass or the slashing canines used by tigers to kill their prey. Apes and monkeys have lost the long muzzle of the mammals, and with it a number of teeth, leaving all primates (the New World monkeys excepted) with only thirty-two teeth instead of the usual mammalian forty-four. Despite many similarities, the teeth of modern primates and of modern humans do show clear differences. As compared with the arched jaw of humans, the ape's jaw suggests three sides of a rectangle, with the sharp-edged incisors in front, the pointed canines at the corners, and the premolars and molars on the sides.

The four pairs of incisors evolved, as their name implies, for cutting. Primates use them for biting into fruits, nuts, and shoots, and for stripping bark from branches. The incisors enable primates, along with many other kinds of mammals, to bite off portions of food that would otherwise be too large to swallow. The sharply pointed canines are smaller in humans than in other primates. These might seem to be associated with a carnivorous way of life — indeed, their prominence in dogs, known scientifically as *Canis,* accounts for their name — but the fact that they are usually much larger in primate males than in females suggests that their function is not directly related to feeding. Males and females do, after all, eat the same foods and would therefore be expected to have similar teeth. Rather, primate males employ their canines for defense and for competitive displays to threaten a rival male. They do this by opening the mouth wide in what appears to be a yawn, drawing back the lips so that the canines are entirely uncovered; to appease another male, on the other hand, an ape or monkey covers the canines with the lips. Humans who display the teeth in a smile intended to appease are doing exactly the opposite. Even so, they usually take care not to display too many teeth, since the wide smile that reveals the canines indicates the scoundrel in melodrama, movies, and folk belief. Although some anthropologists have argued that smaller canines

in humans stemmed from the increasing use of tools for piercing, the canines had already decreased in size, as compared to those of nonhuman primates, at least two million years ago. At the same time, the entire jaw was becoming less massive, making it possible for the skull to become enlarged and thus accommodate a larger brain.

In the course of evolution, as the flat premolars on the sides of the mouth decreased in number from the eight pairs found in most mammals to the four pairs in apes and monkeys, they became more efficient. The back teeth or molars, meanwhile, evolved in such a way as to combine the functions of grasping, grinding, and cutting. This kind of economy has been an ongoing trend in primate evolution as fewer, smaller, and more efficient teeth perform more work. The human's thirty-two teeth are thus more generalized than those of other primates, and considerably more so than the forty-four teeth of most other mammals. The trend toward fewer teeth apparently is continuing; witness the increasingly common absence of the molars farthest to the rear, the "wisdom teeth." Individuals who do have them may suffer from impacted third molars, which frequently have to be extracted by a dentist.

Parents in modern societies often send their children to orthodontists to give them what is now considered a "correct" bite — that is, with the upper incisors slightly overhanging the lower ones to produce the shearing action of a pair of scissors. Considerable evidence, though, indicates that in the characteristic bite of hunter–gatherers, both today and in the past, the upper and lower incisors meet edge to edge, like a pair of pincers. When hunter–gatherers eat a tough haunch of meat, they use the "stuff-and-cut" technique: Part of the haunch is stuffed into the mouth, firmly clamped by the incisors, and then either torn away by a vigorous tug of the hands or sliced off near the lips with a knife. Thus for hunter–gatherers, the incisors are used less as cutting tools than as clamps. If the front teeth are used in this manner several times a day, beginning in childhood, they soon develop in the edge-to-edge position of pincers.

The scissorlike bite of modern humans can be attributed not to genetic or dietary changes but to the practice of cutting food into bite-sized morsels before putting it into the mouth, thereby largely bypassing the incisors. This began in Europe several cen-

turies ago, and much earlier in China, as a result of the introduction of the fork and of chopsticks. Bronze chopsticks have been unearthed from royal tombs dating as far back as 3500 years ago, but they did not come into general use until at least a thousand years later, when the custom became widespread of preparing food in small pieces that could be manipulated with chopsticks and did not require any further cutting at the table. The use of the fork did not really become common until about two hundred years ago, although it had spread through the royal courts of Europe as early as the sixteenth century. At first used to transport food to the plate or to the mouth, the fork was increasingly used to hold down the food on the plate while it is cut into small pieces with a knife — "butchering at the table," as the Chinese derisively call it. In the use of both chopsticks and forks, the result was the same: a reduced involvement of the incisors in eating and a subsequent loss of the edge-to-edge bite of hunter–gatherers.

A second preoccupation in modern societies with teeth and diet concerns caries or "cavities." Although dental decay is often thought of as a disease of civilization, brought on when humans switched to effete or mushy foods, it has in fact been found in many species of mammals — among them rats, pigs, and monkeys — as well as in fossils of early humans. The *Homo erectus* fossils from Java (formerly known as "Java Man" or "Pithecanthropus erectus"), dating from well over half a million years ago, show signs of caries. Although caries are obviously not caused solely by the modern adaptation, they do tend to increase as the diet changes to soft foods and a large intake of sugar. Aristotle touched on the major cause of caries when he asked in his *Problems:* "Why do figs, which are soft and sweet, damage the teeth?" The prevalence of caries among Greeks at this time was no doubt due to their heavy consumption of honey and dried fruit (roughly half of a dried apricot or fig consists of sucrose, one of the simple sugars). Honey and dried fruit were also eaten in large quantities during the Roman occupation of Britain, where toothlessness then became common. Skulls dating from the subsequent Anglo-Saxon period, when the Roman diet was replaced by one that used large amounts of tough meat and abrasive grains, show that caries practically disappeared during that time. The trend was reversed once again in the twelfth century, as sugar became increasingly available from the new trade routes to the Mediterranean that were

opened up by the Crusaders. By the fifteenth century, Venetian ships were bringing a hundred thousand pounds of sugar to England each year. Shakespeare's *The Winter's Tale,* written a century later, gives a shopping list for twenty-four people at a country feast; it includes three pounds of sugar, as well as raisins and other fruits with a high sugar content.

Probably no cultural influence on the evolution of teeth has been more important than cooking. Charles Lamb, in his "Dissertation on Roast Pig," accounted for the origin of cooking in this way: A farmhouse accidentally burns down, and the pigs kept there by its owners are roasted in the flames. A boy poking through the ruins accidentally burns his fingers on the carcass of a pig, cools them in his mouth — and immediately discovers the delicious taste of roast meat. The only probable thing in Lamb's account is that the discovery must have been accidental; the rest of the story is incompatible with what is known about human behavior.

Human beings are extremely finicky about what they eat; the first foods roasted by accident would probably have been disdained, since the taste for roast food is culturally acquired. Why ruin a good haunch of bloody meat or kill the taste of a tuber by putting it into a fire? A human preference for cooked foods must have developed gradually over a very long period of time as the advantages came to be recognized: Cooking destroys the toxins, bacteria, and parasites in food, and it makes the protein in meat and fish easier to digest. Whereas the human digestive system cannot cope with the cellulose and raw starch that make up the bulk of most plant foods, the cellulose walls of plant cells are broken down by heat and the starch is changed chemically into more easily digested sugars. Cooking amounts, therefore, to a sort of external predigestion.

Two basic kinds of cooking are known, one of which must have developed early, the other more recently in human evolution. The process of roasting or applying heat from a fire directly to food is very ancient. The archeological remains of "Peking Man" (*Homo erectus*) at the Choukoutien caves in China, dating from some half a million years ago, indicate that meat was roasted there. Traces of hearths that were apparently used for roasting have also been found in the caves of southern France and of Hungary, and date from approximately the same time. Before the arrival of

Europeans, roasting was the only kind of cooking known to the Australian Aborigines, the Tasmanians, the Tierra del Fuegians who live at the southern tip of South America, and some other hunting–gathering peoples.

Cooking that does not apply heat directly to the food, but transmits it through another medium, is most probably a more recent invention. When the medium is water, the process is boiling; when it is oil, the process is frying. Whereas roasting could have been discovered by accident, hot water is a rare natural phenomenon, not easily produced by humans in the absence of containers that are to some degree waterproof and fireproof. It was therefore long believed that boiling and frying did not develop until after ceramics and metallurgy had been invented, in the Near East between 6000 and 9000 years ago. Human invention did, though, devise ways of boiling food without manufactured pots — by making use of the shells of tortoises, turtles, and large mollusks as containers. A considerably more complex method was to dig a hole, line it with stones and clay to prevent seepage, fill it with water, and raise the temperature of the water to boiling by dropping in heated stones. While the food boils, more and more hot stones are put into the water to keep the temperature high. By these and other methods, peoples lacking ceramic or metal pots that could withstand fire were able to cook their food in a variety of ways. The Tikopians of the South Pacific, for example, baked food on hot stones in earthen ovens; they boiled it by sliding heated stones into wooden bowls filled with water; they wrapped fish in thick leaves and suspended it over a fire (much as seaweed is used at a New England clambake). Despite the limitations of their technology before they obtained manufactured pots from European traders, the Tikopians managed to exploit the possibilities of their environment with an imaginative cuisine.

The origins of cooking are more probably to be found in religion than in the fiction of Charles Lamb. In many societies fire is considered to be a spirit capable of suffusing food with supernatural powers that are thereby passed on to the humans who eat them. Many religious rituals call for animals to be sacrificed, burned, and then eaten — a practice that would have allowed the gradual development of a taste for roast meat. Hunter–gatherers and simple horticulturists must have learned early not

only that certain plant foods are more easily prepared and digested if they have first been cooked, but that others, although poisonous when eaten raw, are so altered by the process to become an edible food. Excavations at some of the earliest villages of the Near East show that wheat was roasted before being mixed with water to make gruel. American Indians even developed a special variety of maize whose kernels burst with heat — the forerunner of today's popcorn.

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The traditional notion that hunter–gatherers must carry on a solitary, unremitting search for food, that they supposedly wake each morning not knowing whether or not they will find the day's supply, and that they usually die young from famine happens to be untrue. Hunter–gatherers, who are not solitary but live in small bands and observe many intricate social rules for the distribution of food, are far from impoverished. The San in the bleak Kalahari Desert forage for food for no more than a few hours a day on the average; moreover, the unmarried young people and those older than fifty do hardly any work at all. Medical examinations of the San have shown that their diet, both abundant and nutritious, has enabled them to escape many of the health problems associated with diets that are common in modern societies: obsesity and "middle-age spread," dental caries, hypertension and coronary heart disease, and elevated levels of cholesterol. And far from being short-lived, many of the San live into their sixties and seventies. An important point made by studies of surviving hunter–gatherers is that their generally excellent nutrition extends to all members of the society and not just to a privileged few — simply because the prevalence of sharing insures that everyone eats the same way. In those rare hunter–gatherer societies where some individuals were notably more privileged, as were the chiefs of the Northwest Coast Indian tribes, the inequality did not usually extend to nutrition.

The beginnings, more than 10,000 years ago, of horticulture and pastoralism led to the emergence of privileged classes whose diet differed greatly from that of the laboring and peasant populations. A study of skeletons from Central America has documented the changes that took place under the Mayan civilization. Between about A.D. 300 and A.D. 900 at Tikal, Guatemala, the average

stature of Mayan males shrank by more than three inches to a mere five feet one inch, a size not much exceeding that of some Pygmies in Africa today. But certain males who during the same period were given elaborate burials at Tikal (and are therefore presumed to have been members of the elite) had an average stature of five feet seven inches, and their life span as compared to that of the commoners was notably longer. Privileged classes with a preferential access to food are a characteristic of the newer cultural adaptations that have been with us to this day.