Humans enter the system

Evolutionary background

During the last part of the dinosaur era, around 65 million years ago, there existed on Earth a small group of tree-dwelling primates that looked something like present-day shrews. Among them were the ancestors of humankind.

By 5 or 6 million years ago in the African savannah, there were some much larger primates walking with an upright posture. One particularly well-preserved fossil is that of a young female, which was found in Ethiopia and dated to about 3 million years ago. She is known informally as Lucy, and the species she belonged to has been called *Australopithecus afarensis*. She had a skull very like that of a chimpanzee, with a brain of around 500 cubic centimetres.

Two and a half million years ago there were primates in Africa making stone tools. One species, called *Homo habilis*, was only 90–120 centimetres tall, but it had a brain with a volume of about 800 cubic centimetres, which is about 300 cubic centimetres larger than that of a chimpanzee. These animals consumed both plant and animal food. Another, rather similar species was *Homo rudolfensis*, and it existed at about the same time.
Around 1.8 million years ago, a taller species named *Homo ergaster* was living in the same area. This was the first hominid to have an essentially modern form, and it is possible that the three species *Homo habilis*, *Homo rudolfensis* and *Homo ergaster* were all living in the same region at the same time.

It seems that *Homo ergaster* spread out of Africa into Europe and Asia about 1 million years ago, giving rise eventually to a form of humanity referred to as *Homo erectus*. Remains of this species have been found as far east as Java, Indonesia. These people were 150 to 180 centimetres tall and their skulls had an uninterrupted bar of bone above the eyes. Their brains were between 1,000 and 1,200 cubic centimetres. *Homo erectus* may have survived in eastern Asia until around 300,000 years ago, and possibly even to 25,000 years ago.

Fossil remains have been found in Europe and Africa of humans that lived 300,000 to 800,000 years ago and that appear to be intermediate between *Homo erectus* and modern humankind, although their relationship to earlier and later forms is unclear.

From about 200,000 years ago, and during most of the first part of the fourth, or Würm, glaciation, western Europe was occupied by a distinctive form of humanity classified as *Homo neanderthalensis*. These people were of stocky build and most of the men were a little over 152 centimetres tall, and the women a little shorter. Their skulls were flattish on top and noticeably rounded at the back, and they had the pronounced brow ridge reminiscent of *Homo erectus*. They had massive musculature and jaws and the brains of adults ranged from 1,450 cubic centimetres to 1,650 cubic centimetres in volume, which is rather larger on average than that of modern humankind. They were well acquainted with the use of fire, hunted big game and dressed in animal skins. They used paints to decorate their bodies and sometimes they buried their dead. Recent evidence suggests that there were other human species or subspecies living in Asia at around this time.

It is now clear that humans with the physical characteristics of our own species, *Homo sapiens*, were in existence in Africa and probably elsewhere, around 200,000 years ago. They were tall people with rounded skulls and steep foreheads, and their average cranial capacity was about 1,400 cubic centimetres. They had well developed chins, and their brow ridges were only moderately developed and were not
continuous from side to side. If we could bring some of them back to life, dress them in modern clothing and set them loose on a city street, they would be indistinguishable from some of the better specimens of modern humanity.

The emergence of human culture

Over the hundreds of thousands of years that these anatomical changes were taking place in our hominid ancestors, something else was also happening of tremendous significance. This was the evolutionary development of the ability of humans to invent and memorise symbolic language, and to use it to communicate among themselves. This linguistic aptitude depends both on characteristics of the human brain and on special anatomical arrangements in the larynx, pharynx and tongue, which permit us to utter an amazing range of different sounds.

Along with the evolution of the aptitude for symbolic language, there was a parallel emergence of the capacity to compose, make and enjoy music. As in the case of human language, this trait is unique in the animal kingdom.¹ The making and appreciation of music has become a hugely important aspect of human experience, and this has possibly been so since the very earliest days of our species.

The aptitude for language led to the progressive accumulation of shared knowledge, beliefs and attitudes in human groups. That is, it led to human culture.

Another characteristic of human behaviour is the ability to invent new technologies and to pass on this technical know-how from one individual to another and from generation to generation. Some other primates and some birds exhibit a trace of this ability. In humans, the aptitude for technology is greatly assisted by the extraordinary dexterity of our species and by spoken or written language.

The rapidity of the development in evolution of the human capacity for language and culture indicates that, once a rudimentary ability to invent and use symbolic language emerged, it was immediately of major biological advantage. Under the prevailing conditions its chief

¹ Some birds, of course, sing; but the pattern of sound is largely genetically determined.
advantage probably lay in its role in the exchange and storage of useful information about the environment. The fact that culture was of biological advantage under the conditions in which it evolved does not mean, however, that it will necessarily still be advantageous under conditions that differ significantly from those of the evolutionary environment.

Human culture thus came into existence as a new kind of force in the biosphere — a force destined eventually to bring about profound and far-reaching changes across the whole planet. Its impacts on the rest of the living world during the long hunter–gatherer period of human history were, however, modest in comparison with those of later times after the advent of farming, and especially after the Industrial Revolution.

Geographical distribution and genetic and cultural variation

Despite their unimpressive physical strength, biting power and speed of running, *Homo sapiens* proved to be biologically successful. They spread from Africa across Asia and, by 60,000 years ago, they had reached Australia. Around 45,000 years ago they became the dominant human type in Europe and Asia, displacing the Neanderthals and other human species or subspecies. They were responsible for a marked diversification and sophistication of culture, as reflected in the many kinds of artefacts they left behind in the form of scraping tools, knives, burins, awls, needles, spatulas, weapons of various kinds, pendants, necklaces, armbands, musical instruments, statuettes and rock paintings.

By 40,000 years ago, modern humans had spread throughout Africa, Asia, Europe and Australia. It seems that they did not arrive in the Americas before 35,000 years ago, and perhaps not until around 16,000 to 13,000 years ago.

The spread of humankind across the globe was associated with some divergence in the genetic characteristics of populations, resulting in observable differences between people living in different parts of the world — differences, for example, in stature, facial features and colour of skin, hair and eyes. Other genetic differences, like variability in the distribution of blood-group antigens between populations
Humans in their natural environment

The term ‘natural environment’ is used here to mean the environment in which a species evolved and to which it has become genetically adapted through natural selection. The natural environment of the human species is, therefore, the environment of our hunter–gatherer ancestors. There have been too few generations since those days for there to have evolved major genetic changes rendering humans significantly better adapted to the conditions of modern civilisation. Biologically, we are basically the same animal as our forebears of, say, 15,000 years ago. We share their innate biological characteristics.

General biology

The conditions of life of hunter–gatherers varied significantly from time to time and place to place. They lived in many different kinds of habitats, ranging from dense tropical rainforests, semitropical savannah and deserts, through to temperate forests and grasslands to the ice-covered plateaus in the far north of Europe, Asia and America. Most of them, however, spent their lives in mild to warm, relatively fertile areas with moderate rainfall.
The following brief account of the typical conditions of life and ecology of primeval people covers mainly those aspects that are likely to have been universal or, at least, usual among hunter–gatherers.2

As in the case of animals living under natural conditions, most of the time most of the people had plenty of food and were well nourished. The typical diet consisted of a wide range of different foods of plant origin, including berries and other fruits, nuts, roots, grains and leaves, and a certain amount of cooked lean meat making up roughly 20 per cent of the diet by weight. The meat had a low fat content and a high ratio of polyunsaturated to saturated fat. The diet of newborn infants was, without exception, human milk.

Diets varied, however, from one region to another. Eskimos consumed a higher proportion of meat than people living in the African savannah where, at some times of year, the diet contained only a small amount of animal protein.

The time spent collecting food varied according to local circumstances but, in general, averaged two to three hours a day. Much of the food was brought back to the group’s campsite for sharing.

An essential activity associated with the acquisition of food was the manufacture of weapons for hunting and of tools for cutting meat and scraping animal skins. Stone spearheads, axes and most other weapons and implements were usually made by men, while ornaments were made by both men and women.

The amount of food energy required by humans depends on both their size and their pattern of behaviour. In our own society, an adult male leading a rather sedentary life might use about 10 megajoules per day. About half of this energy is used in basic metabolic processes and the rest in voluntary muscular activity. The same person, leading a moderately active life, would use about 12 megajoules a day, but he could use as much as 30 megajoules if he was performing exceptionally heavy work in a cold climate.

2 The term ‘primeval people’ is used here to mean people who are hunter–gatherers. ‘Primeval society’ means hunter–gatherer society.
It is likely that the daily use of food energy by adult males in hunter–gatherer communities would have been between 15 and 20 megajoules. Some idea of the relationship between food energy and physical work can be gleaned from the following facts: one teaspoonful of sugar (about 0.1 megajoules) is sufficient fuel for an adult male to run for five minutes; and it takes seven hours of non-stop moderate cycling to ‘burn off’ 0.5 kilograms of body fat.

Patterns of rest and sleep in primeval society varied according to circumstances. In general, people tended to sleep or to rest when they felt like it, and when there was nothing better to do. Most sleep was taken during the hours of darkness, but short naps were also common during the daytime.

Reliable figures are not available on fertility rates in recent hunter–gatherer populations. It seems, however, that a common picture was for couples to have three or four children, two or three of which could be expected to reach adulthood and to become parents themselves.

**Box 3.1 A generational perspective**

Picture yourself on the stage of a large theatre with room for an audience of 2,000. In your mind’s eye, place your mother in the seat at one end of the front row, and then her mother next to her and so on — until you have filled the place with 2,000 generations of mothers and daughters.

The great majority of your maternal ancestors in the theatre would have known nothing of agriculture or the urban way of life. Only the women in the front 20 or so rows would have been alive since the time when farming first began, and only those in the front six or seven rows would have lived after the earliest cities came into existence, although very few of them are likely to have actually lived in cities.

You could fill at least one other similar theatre with earlier maternal hunter–gatherer ancestors belonging to the species *Homo sapiens*. All these women really existed, and they lived in a state of health, at least until the birth of a child.

If you were to carry out the same mental exercise using an amphitheatre with room for 200,000 people, the individuals in the rows at the back would not be members the genus *Homo*.

Source: Stephen Boyden
Social organisation and psychosocial aspects of life experience

Humans are social animals and, in hunter–gatherer societies, each individual belonged to a close-knit group or band in which there was constant exchange of information on matters of mutual interest. The great majority of social interactions were between individuals who knew each other well. The size of these bands was variable and was largely determined by prevailing ecological conditions. People were very aware of their responsibilities as determined by the prevailing social norms, and there was a good deal of coming and going between neighbouring bands.

There was a certain division of labour within bands in that most of the gathering of plant foods and small animals was done by women, while the hunting of larger animals was mainly a male activity. Women played the major role in caring for small children.

Other activities included various forms of creative behaviour, including making tools, weapons and ornaments, and telling stories. Much time was spent in conversation and making music and dancing were common activities.

Serious physical violence and other antisocial behaviour within bands was probably not common, at least not under reasonably favourable ecological conditions. Arguments among group members certainly occurred, however, sometimes leading to physical violence. The frequency of such violence varied from group to group and from time to time.

The behaviour of humans in the natural environment, or indeed any other environment, can be described at two levels: basic behaviour and specific behaviour.

Humans share certain basic behavioural tendencies. These range from the obvious: behaviours that are linked closely with physiological functions, to behaviours of a psychosocial nature, which are more difficult to define. The former include the tendencies to eat when hungry, to drink when thirsty, to copulate when appropriately stimulated, and to move from less comfortable to more comfortable positions. The more psychosocially oriented basic behavioural
tendencies include the tendencies to identify with an in-group, to seek the approval and avoid the disapproval of members of the in-group, to show loyalty to members of the in-group, and to seek to maintain or improve status within the in-group.

While these basic behavioural tendencies are evident in all human populations, their specific manifestations vary greatly according to circumstances and, especially, according to the prevailing culture. While humans all over the world tend to seek the approval of the members of the in-group with which they identify, the criteria of approval, which are largely culturally determined, differ from one group to another. This particular basic behavioural tendency can, in different cultural settings, lead to specific behaviours as different as baking a cake or throwing a bomb into a crowded bus.

Culture can also reinforce or suppress basic behavioural tendencies. In some societies, the tendency to compete is greatly reinforced while, in others, it is suppressed. Creativity is encouraged in some cultures, but discouraged in others.

The topic of human aggression has received a great deal of attention from academics. Some have argued that there is an innate aggressiveness in humankind towards other humans, especially in the case of males. According to one school of thought, this aggressiveness builds up in the individual until it finds a behavioural outlet. Others argue that it is culture that determines whether humans behave aggressively towards one another. The view taken here is that, while humans are not ‘innately aggressive’, there is an innate tendency for people to behave aggressively in response to perceived threats to themselves or to their in-group. Cultural factors have an important influence on what is, and what is not, perceived as a threat. Aggressive behaviour can also be a consequence of cultural pressures in societies in which aggression and violence are seen as criteria for praise and approval.

Judging from the evidence derived from research into contemporary hunter–gatherer groups, primeval societies were not characterised by constant hostilities with neighbouring bands. On the other hand, violent interaction, sometimes resulting in deaths, certainly occurred from time to time.
While overt physical aggression towards out-groups is not inevitable in humankind, there does seem to be a universal tendency of humans to be suspicious of strangers.

There is universal concern among humans for the well-being of members of the in-group to which they belong, and especially of children, but there is no evidence for an innate concern for the well-being of members of out-groups.

In most hunter–gatherer societies there was no rigid hierarchical structure. Leadership was usually determined spontaneously and was based mainly on prowess and personality. One individual might be leader in a hunt, another in a honey-collecting expedition, another in music-making or dancing, and another in religious rituals.

Apart from the division of labour based on age and gender, there was no occupational specialisation of the kind found in later societies. All the women took part in collecting plant foods, sometimes assisted by men, and all the men participated in hunting and making weapons.

Other psychosocial features of the primeval lifestyle include the following:

- most individuals were part of a care-giving and care-receiving network
- there was considerable variety in daily experience
- the immediate environment was full of interest to everybody
- most people experienced personal creative behaviour on a daily basis
- there was spontaneity in behaviour
- aspirations were short term and of a kind likely to be fulfilled
- most people experienced a sense of personal involvement in daily activities, a sense of belonging to a group and to a place, a sense of challenge and a sense of responsibility.

**Children**

The life conditions of children in primeval societies reflected the spontaneous nature and relatively uncomplicated social organisation of the communities. Babies were kept close to their mothers for the first year or so of life but, after this, they might be left at the camp to
be minded by relatives or friends when their mothers went gathering. For the first few years, children were indulged by their parents and other members of the band and they were seldom severely punished for transgression of norms. Customs differed from one hunter–gatherer society to another with regard to the control of behaviour in children after the age of five or six, although it is likely that the laissez-faire attitude persisted in most groups.

The learning experience of children did not involve any formal program of teaching. The process was spontaneous and was based on such basic behavioural characteristics as the tendencies to imitate and to seek approval. Much learning in childhood took the form of listening to, observing and copying slightly older children, who were in turn learning from their older siblings or peers. Playing games based on mimicry of adult behaviour was universal among hunter–gatherer children. Mild aggressive behaviour was not uncommon in children, although it seldom resulted in serious injury.

**Arts and crafts**

The human species is noted for its capacity to make and use tools. Some other species of animals, however, also use tools on occasion. Otters make use of stones to break open molluscs, and both chimpanzees and some birds not only use sticks of wood for a variety of purposes but sometimes also manufacture simple implements; and some birds use short sticks to prise insects from under the bark of tree trunks. Humans, however, are clearly more adept at inventing, manufacturing and using tools than any other species.

In primeval society, most individuals spent part of each day making or shaping something by hand or creating new patterns in some other way. Recent cultural developments have reduced the incentives and opportunities for creative behaviour for a high proportion of the population, depriving people of an important source of enjoyment and self-fulfilment. Much has been written about human creativity, but most of this literature has been concerned with the activities only of quite exceptional specimens of humanity, such as da Vinci, Michelangelo, Picasso, Mozart and Beethoven. Less attention has been paid to creative behaviour as a feature of the everyday life of ordinary people.
Ecology

While the existence of language and the use of hunting weapons certainly had some effects on the ecological interrelationships between humans and other species living in their immediate environment, the overall ecological impact of hunter–gatherers was not great. They fitted into the food chains in much the same way as any other omnivorous species — that is, they acquired their energy in the form of organic molecules in plant and animal foods, and they were eventually consumed by predators, scavengers or decomposing microorganisms. In the ecosystems in which hunter–gatherers lived, it is likely that only about 1/10,000 to 1/100,000 of the energy fixed by photosynthesis actually flowed through the human population.

The capacity for culture, together with human dexterity, did lead to one particularly important difference between the ecology of our species and that of other mammals. The regular use of fire and the manufacture and use of tools added an extra dimension to the metabolism of human populations — referred to as technometabolism.

Technometabolism is defined as the pattern of flow of energy and materials into, through and out of a human population that results from technological processes. It contrasts with biometabolism, which is the flow of energy and materials into, through and out of human organisms. Technometabolism is a product of cultural evolution and is a new phenomenon in the history of life on Earth. It is of tremendous significance ecologically and in many other ways.

The use of fire, in particular, was a development of enormous ecological significance. It was the first example of the regular and deliberate use by humans of extrasomatic energy — that is, energy used outside the human body, as distinct from the somatic energy, which is consumed in food and which flows through the human body.

It has been estimated that the introduction of the regular use of fire in human populations approximately doubled the per capita energy use, bringing the total energy used per day per person (men, women and children) to about 16 megajoules — that is, roughly 8 megajoules used in biometabolism and 8 megajoules in the burning of wood.
Health

As in the case of all other animals living in their natural environments, most of the time most of the members of hunter–gatherer communities were in a state of good health. Indeed, they had to be in order to survive and successfully reproduce under the demanding conditions of their lifestyle and habitat.

Most people:

• would have been well nourished. There is no diet better for any animal than that which is typical of its natural lifestyle and environment. Undernutrition, malnutrition and obesity were rare in normal circumstances, although, in periods of unusual drought, people’s health would have deteriorated

• would not, before contact with people from urban societies, have suffered from such infectious diseases as influenza, the common cold, measles, cholera, typhoid and plague. There were simply not enough humans living together to support these pathogenic microbes

• would not have suffered from such organic disorders as appendicitis, duodenal ulcer, diverticular disease of the colon and cardiovascular disease. It is known that blood pressure tends to remain more or less constant in adults in primeval societies after the age of about 20 years, rather than increasing steadily after this age, as is frequently the case in modern communities.

On the other hand, the primeval lifestyle was characterised by some built-in hazards that are absent from modern society. There was a considerable risk of serious injury acquired during hunting, and severe wounds often became infected, leading to gangrene or septicaemia. Any incapacitation due to injury or ill health was of much greater survival disadvantage in the hunter–gatherer setting than under the protective conditions of modern civilisation. People did not have the benefit of the artificial antidotal measures like antibiotics, chemotherapeutic agents and surgery that are available today. The average age in primeval populations was typically around 25 years.
Comment on human health needs

Numerous definitions of health have been proposed for humankind. Here we adopt a biological definition similar to that given above for all living organisms: health in humans is that physical and mental state that would have been likely to ensure survival and successful reproduction. Another appropriate definition is: health is that state of body and mind conducive to, and associated with, full enjoyment of life.

Of greater practical interest than the definition of human health is the identification of the health needs of our species. There are various approaches to this issue, ranging from one’s personal experience to the application of knowledge from medical research. Here we adopt a biological line of attack based on the evolutionary health principle (see the section ‘Health and disease’ in Chapter 2), taking the life conditions of humans in their natural environment as a starting point. These are the conditions to which our species was genetically adapted through evolution and they satisfied the survival, health and reproductive needs of our ancestors for many thousands of generations. In accord with the evolutionary health principle, significant deviations from these conditions are likely to be associated with signs of maladjustment or ill health.3

The evolutionary health principle clearly applies to a wide range of physical aspects of life conditions in humans. There is no diet better for humankind than that which was typical for hunter–gatherers. It is also clear that the principle is applicable to some aspects of behaviour. Marked deviations from natural sleeping patterns cause

3 This does not mean that evolutionary change in the human species has come to a halt. There has been a relaxation of some selection pressures that were powerful in the hunter–gatherer environment and, in the long term, this will result in genetic changes in human populations (J.M. Rendel, 1970. ‘The time scale of genetic change’. In S. Boyden (ed.), The impact of civilisation on the biology of man. Australian National University Press, Canberra). There have also been some new selection pressures associated with the advent of farming that have produced changes in some populations. A well-known example of this is the emergence and spread in European populations of lactase production into adulthood in response to the availability of bovine milk as a food source. For discussion of this change and for other examples, see G. Cochrans & H. Harpending, 2009. The 10,000 year explosion: How civilisation accelerated human evolution (Basic Books, New York).
maladjustment, and health is likely to be impaired if patterns of physical exercise deviate markedly from those of humans in the natural habitat.

There are good reasons for supposing that the principle also applies to psychosocial and relatively intangible aspects of life experience. The conditions of life of hunter–gatherers are usually characterised, for example, by incentives and opportunities for creative behaviour, a sense of personal involvement in daily activities and plenty of convivial social interaction. Most of us would agree that such conditions are likely to promote health and well-being in our own society.

Taking our knowledge of the conditions of life of hunter–gatherers as a starting point, we can put together a working list of the physical and psychosocial conditions that are likely to promote health and well-being in our species (Box 3.2). They are referred to as universal health needs because they apply to all members of the human species wherever or whenever they may be living.

Most of the items on the list of postulated psychosocial health needs, like creative behaviour and sense of personal involvement, cannot be defined and measured as easily as physical health needs, but this does not mean that they are less important.

It is true that not every item on this psychosocial list is absolutely essential for health. Lack of satisfaction of one health need may be offset to some extent by the satisfaction of others. On the other hand, every item on the list will, if satisfied, make a positive contribution to health and well-being.

Unfortunately, conventional measures of social well-being in our society today do not take the less tangible psychosocial aspects of life experience into account, nor do they feature on the platforms of the major political parties. It is important, however, that deliberate effort be made to take these less tangible factors into consideration in any assessment of current human life conditions or in planning for the future.
Box 3.2 Universal health needs of the human species

Physical needs

- clean air (not contaminated with hydrocarbons, sulphur oxides, lead, etc.)
- a natural diet (i.e. calorie intake neither less than nor in excess of metabolic requirements; foods providing the full range of the nutritional requirements of the human organism, as provided, for example, by a diverse range of different foods of plant origin and some cooked lean meat; a diet that is balanced in the sense that it does not contain an excess of any particular kind of chemical constituent or class of food; foods with the physical consistency of natural foods and containing fibre; foodstuffs devoid of potentially noxious contaminants or additives)
- clean water (free of contamination with chemicals or pathogenic microorganisms)
- absence of harmful levels of electromagnetic radiation (e.g. alpha, beta, gamma, ultraviolet and x-rays)
- minimal contact with parasites and pathogens
- protection from extremes of climate (temperature, wetness)
- noise levels within the natural range
- a pattern of physical exercise that involves some short periods of vigorous muscular work and longer periods of medium (and varied) muscular work.

Psychosocial needs

- an emotional support network, providing a framework for care-giving and care-receiving behaviour, and for exchange of information on matters of mutual interest and concern
- the experience of conviviality
- opportunities and incentives for cooperative small-group interaction
- levels of sensory stimulation that are neither much lower, nor much higher, than those of the natural habitat
- opportunities and incentives for creative behaviour
- opportunities and incentives for learning and practising manual skills
- opportunities and incentives for active involvement in recreational activities
- opportunities for spontaneity in human behaviour
- variety in daily experience
- short goal-achievement cycles and aspirations of a kind that are likely to be fulfilled
- an environment and lifestyle that is conducive to a sense of personal involvement, purpose, belonging, responsibility, challenge, comradeship and love
- an environment and lifestyle that do not promote a sense of alienation, anomie, deprivation, boredom, loneliness, or chronic frustration.

Source: Stephen Boyden
Brief comment is called for on the concept of stressors and meliors. Stressors are experiences that cause anxiety and distress and they are a normal aspect of life. If they are short-lived and not too severe, they can be seen as contributing positively to the quality of life and well-being; but if they are excessive and if they persist, they can interfere seriously with both mental and physical health. Equally important are experiences that have the opposite effect to stressors and that give rise to a sense of enjoyment. Such experiences have been called meliors. Common meliors include the experience of creativity, fun, aesthetic enjoyment and conviviality.

Every person can be considered at any given time to be at some point on a hypothetical continuum between a state of distress and a state of enjoyment. Their position on this continuum is largely a function of the balance between meliors and stressors in their recent experience.

The cultural environment has an immense influence both on the levels of meliors and stressors in an individual’s daily experience as well as on the nature of the factors that cause them. Culture also affects the energy and pollution costs of attempts to avoid stressors or to experience meliors.