

A fascinating human self-portrait

Barry Myers
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The Human Body Documentary series presented by Professor Robert Winston

Available on video and CD-ROM from the BBC.

Book accompanying the series: The Human Body by Anthony Smith, published by the BBC

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The British Broadcasting Corporation (BBC) recently screened a series of five documentary programmes collectively entitled *The Human Body*. These charted the life of a human being from conception to death. Professor Robert Winston, an expert in human fertility who helped pioneer "test tube babies", presented the series.

The series provided a detailed examination of the processes that take place within the human organism from the period in the womb right through to death. New techniques of filming and microsurgery provided spectacular footage of the complexities of the human organism.

The first programme dealt with conception, embryonic development and birth. It showed an egg leaving the ovary and travelling down the fallopian tubes to be fertilised by a sperm.

Winston highlights the unique character of human childhood as compared to that of other mammals and even primates. Humans are born at a very early stage in their biological development. They are completely helpless and totally dependent on maternal care for survival. In contrast, less complex mammals like antelopes are able to walk and flee predators shortly after birth. Even baby chimps can cling to their mothers. The evolutionary advantage which accrues to humans by being born at such an early stage lies in their intellectual development. Their long period of childhood enables humans to respond to many varied physical stimuli from the environment and creates the "hard wiring" of the interconnecting neurones (nerve cells) in the brain. This is a process that requires much energy. In the first year of a child's life 60 percent of the nutrition it receives goes to feed the growing brain.

The second programme dealt with the process of adolescence, in which the child becomes an adult. The gender of a child is determined genetically by the chromosomes, structural carriers of hereditary characteristics. If the sperm carries an X chromosome it will be a girl, if a Y chromosome a boy. For up to six weeks the foetus is sexually undifferentiated, but then hormones (chemical "messengers") kick in to produce testes or ovaries and the appropriate external sexual organs.

Compared to other mammals, puberty in humans, the beginning of sexual maturation, takes place at a relatively advanced age. Sheep begin to show the onset of sexual maturity at about six

months, cattle at 12 months and gorillas at eight years. It would seem to be an evolutionary benefit to reproduce and pass on any genetic advantages as soon as possible. But mankind has evolved as a social being in which a high degree of co-operative behaviour is necessary for survival. Humans have to learn to deal with complex social relationships. Thus the prolonged process of childhood, with its emphasis on play and learning, enables individuals to develop necessary social skills.

The third programme concentrated on the brain. It included remarkable images of a single brain cell magnified 10,000 times firing off an electrical impulse during the thought process. The brain represents more than the sum of its parts. Its great ability, including abstract thought and sophisticated language, is a result of its enormous interconnectivity and complexity. The neurones making up the human brain have more interconnections than there are atoms in the universe. Winston explains that in the course of human evolution, spanning over two and a half million years, the volume of the brain has increased from half a litre to one and a half litres. This represents an increase of about 150,000 nerve cells in the brain for each generation up to about 100,000 years ago, since which time its size has remained constant. The brain of an adult uses up about one-fifth of the body's energy needs.

The cerebellum or lower brain, also known as the reptile brain, is similar in structure in most vertebrate animals. This part of the brain enables tasks to be learnt that then become "natural" and which do not require thinking. Humans are able to perform such seemingly basic tasks as running, sitting or standing automatically. Winston notes that these "simple tasks needed enormous concentration and effort to learn as a child," but "adults can do them literally without thinking because the cerebellum has stored them as a series of routine instructions. This frees the higher brain or cerebrum for more complex tasks."

In humans the main evolutionary development of the brain has taken place in the cerebrum. This resembles the wrinkled bilateral shape of a walnut. The highly convoluted surface permits many more interconnections between neurones which gives the human brain its enormous cognitive power.

The programme explained the unique qualities of mankind by showing the diverse elements brought together in humans through the process of biological and social evolution. An essential factor is that our pre-human ancestors left their tree dwelling existence and developed bipedal motion---walking on two legs --leaving their arms free. This eventually led to our ability to make dextrous, sophisticated movements with our hands. The opposable thumb, the ability to touch each finger with the thumb, has developed to an extraordinary degree in humans as compared to other primates.

The book accompanying the series relates the discovery of hominid/human-like footprints found in Tanzania, which are 3.5 million years old. The footprints show that a bipedal creature must have made them. At that time in human evolution the creatures must have been ape-like with only a modest brain capacity.

The use of bipedal motion and the development of the hand had a positive impact on the development of the brain, increasing the intellectual development of ancestral man. The hands of modern man have a very extensive nerve supply, enabling humans to make very fine and skilled manipulations, such as those undertaken by a surgeon. The use of tools, whilst not unique to humans, has been developed far beyond that of any other animal.

Another important evolutionary development was the development of language. It is not clear when this began, but it has major importance for mankind's ability to operate as part of a co-operative social group.

The programme and the accompanying book also reflect on the concept of consciousness. Humans can not only deal with abstract concepts and make complex intellectual manipulations, they are also aware of their own existence. The human brain is the first natural organ able to start the analysis and explanation of itself. Whilst a human may not have the largest brain in the animal kingdom, its billions of cells with their trillions of interconnections give it this intellectual potential. The concept of consciousness, along with the development of "artificial intelligence" in computers, is one of the most exciting areas of current scientific research.

The final two programmes dealt with ageing and death. As humans age physical changes take place: eyesight weakens, skin becomes thinner and less elastic, men may go bald and hearing deteriorates. An old person is not able to hear high frequency noises. A remarkable piece of film using electron microscopy showed how tiny hair-like cells in the cochlea or middle ear vibrate when subjected to a noise. A single cell was seen responding to a particular noise. These hair cells are arranged in banks, in a V shape. As a person ages these cells progressively die off, leading to loss of hearing.

Professor Winston explained that all the cells in the human body (except brain cells) renew themselves, with old cells dying and being replaced. The rate of renewal depends on the type of tissue. Blood renews itself completely three times in a year, the gut lining is renewed every three days and the skeleton is renewed every four years. This means that no part of the body, even in very old people, is more than 10 years old. So why do people look old?

One theory is that ageing occurs because of mistakes that build up in the copying and renewal process of the cells. Winston likened this to the degradation in quality that takes place if a film is copied on videotape, and then a further copy is made of that on another videotape, and so forth. A similar process can be seen when photocopies are made from photocopies. Another theory is that oxygen, which naturally contains a small proportion of "free radicals", i.e., ionised or electrically charged oxygen, can damage molecules and hence cells and tissues. It is known that smoking and sunlight, which induce free radical production, can accelerate the ageing process. However, it is still an area of research with many unresolved questions.

The final programme dealt with death, in particular with the death of Herbie, a 63-year-old antiques dealer who had retired to the west coast of Ireland with his wife. He was diagnosed as suffering from inoperable stomach cancer in the autumn of 1996. The programme dealt sensitively with the thoughts and feeling of the man, his wife and friends as he approached death. Herbie, a convinced atheist, hoped that the film would help others cope with their own demise.

Professor Winston explained that death is not so much a single event, as a process. Using a heat-imaging camera he showed the heat draining out of a recently deceased body. He explained that because of the advances in medicine and social welfare, the number of childhood deaths in the "developed world" had decreased dramatically. The most common causes of death today in the developed world are the diseases of old age, cancer, strokes and heart disease.

The definition of death has altered as advances in medicine have been made. At one time death would have been defined as the cessation of heartbeat and breathing. The programme showed a heart by-pass operation where the heart was completely stopped and blood flow and breathing taken over temporarily by machine. Today, the definition involves the death of the brain stem, the primitive brain that lies beneath the larger more complex brain and is responsible for the control of automatic processes such as breathing.

One of the most interesting points in the last programme was its treatment of the phenomenon of "near-death experiences". Those who have experienced such events often describe, in mystical and religious terms, going down a tunnel of light and feeling deep joy, before being "called back". Winston presented a rational and materialist explanation of this phenomenon. The tunnel of light can be explained by the loss of peripheral vision, as the loss of oxygen in the brain leads to the uninhibited firing off by neurones in the brain. The visual field has more neurones in the centre, so giving the tunnel effect. The brain also produces substances called endorphins, which have an opiate-like effect and can produce hallucinations and a feeling of extreme well-being. To support his explanation, Winston showed dramatic footage of military pilots losing consciousness whilst being subjected to enormous gravitational forces in a centrifuge. The pilots reported similar effects as those described for near-death experiences: a tunnel of light and sensations of euphoria before passing out.

Winston concludes by addressing the way that all humans truly live on after death. He explained that the human body is made up of matter that has existed since the beginning of the universe. On death this is recycled in the natural world, some of the atoms even providing the building blocks for future humans.

The programme makers should be congratulated for producing an accessible programme put over with obvious enthusiasm by its presenter.



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