Evolution of the Brain

Over the past millennia many believed that the very cores of our beings – our cognition, our minds, our consciousness – reside in our hearts. Now of course we know that our brains have this distinction.

In 1838, two decades before he published his *Origins of Species*, and when he was cautiously probing his ideas, Darwin wrote in his notes that “the problem of the mind cannot be solved by attacking the citadel itself. – The mind is a function of body”. Only much later, in 1872, did he grapple with the problem of the mind in a book entitled “The Expression of the Emotions of Man and Animals”. There he argued that both humans and other animals express the same state of mind by the same movements. Darwin had no idea of the mechanism for natural selection related to physical characteristics, let alone the mind. But we now have detailed knowledge of the unity of life for all species – the underlying genetic basis that provides for natural selection, the genetic code itself, and the mechanism that powers life. Can we do the same for mental capacities? This is the topic of the present chapter.

How far down the tree of life do we find brains? By definition one-celled organisms cannot have brains – unless the entire organism is a neuron! Actually, some unicellular eukaryotes do have remarkable capabilities for such apparently simple organisms, and one of them, the *Paramecium*, is sometimes referred to as the ‘swimming neuron’. Some multicellular eukaryotes, such as the sponges, do not have a nervous system, while others, such as the starfish and the jellyfish, have a decentralized nervous system with no brain.
Most invertebrates have brains. These include insects, crustaceans, octopuses and squids. As invertebrates have been around for well over half a billion years, it has been assumed that they were the first to have brains. One well-studied invertebrate is *C. elegans*, a tiny worm with just 302 neurons. Another is the well-known fruit fly *Drosophila*. Much has been learned about some of these brains, and that knowledge is relevant to human brains.

Most relevant to human brains, however, are the vertebrates, all of which have brains. Simple anatomical examination reveals a striking and obvious pattern of evolution. Mammalian brains in particular share a common architecture with the human brain. As Elman et al. (1996) wrote, “There is no evidence that humans have evolved new neuronal types and/or new forms of neural circuitry, new layers, new neurochemicals, or new areas that have no homologue in the primate brain.” In other words, the ingredients are identical. The common fundamental components are the forebrain, the midbrain, and the hindbrain, which is connected to the spinal cord. The most basic functions involve input of sensory information and output in the form of motor functions. In mammals there is a well-established correlation between brain size and body size, with some scatter related to mammalian type. The human brain lies further above the correlation line than others. The correlation is obviously due in part to the needs of the body, but it may also be related to behavioural aspects, such as the size and complexity of the social group.

The most obvious part of the mammalian brain is the cortex (also common to other mammals), which covers other parts of the brain and has a well-known characteristic convoluted and crumpled appearance. If the human cortex is smoothed and spread out, it is seen to be a sheet 2–5 mm thick covering an area equivalent to that of about four sheets of typing paper. It has to be crumpled in order to fit inside the skull. It has six main layers (which originated in early mammalian times), but vast networks of connections span the entire thickness. The outer layers are grey due to the many neurons or cells (the ‘grey matter’), but its interior is white due to the mass of axons that carry signals between the neurons. The brain has two distinct hemispheres, which are joined together by a large bundle of nerves. Buried under the cortex are several other well-known regions of the brain, which will be outlined in the next chapter.