Behavioral traits are transmitted from parents biology essay

Science, Biology

GeneticsScientific study of how physical, biochemical, and behavioral traits are transmitted from parents to their offspring. The word, in this sense, was popularized in the early 20th century by the British biologist William Bateson. Geneticists are able to determine the mechanisms of inheritance because the offspring of sexually reproducing organisms do not exactly resemble their parents, and because some of the differences and similarities between parents and offspring recur from generation to generation in repeated patterns. The investigation of these patterns has led to some of the most exciting discoveries in modern biology. Emergence of GeneticsThe science of genetics began in 1900, when several plant breeders independently rediscovered the work of the Austrian monk Gregor Mendel, which, although published in 1866, had been virtually ignored. Working with garden peas, Mendel described the patterns of inheritance in terms of seven pairs of contrasting traits that appeared in different peaplant varieties. He observed that the traits were inherited as separate units, each of which was inherited independently of the others (see Mendel's Laws). He suggested that each parent has pairs of units but contributes only one unit from each pair to its offspring. The units that Mendel described were later given the name genes. Physical Basis of HeredparticySoon after Mendel's work was rediscovered, scientists realized that the patterns of inheritance he had described paralleled the action of chromosomes in dividing cells, and they proposed that the Mendelian units of inheritance, the genes, are carried by the chromosomes. This led to intensive studies of cell division. Every cell comes from the division of a preexisting cell. All the cells that make up a human being, for example, are derived from the successive divisions of a single cell,

the zygote (see Fertilization), which is formed by the union of an egg and a sperm. The great majority of the cells produced by the division of the zygote are, in the composition of their hereditary material, identical to one another and to the zygote itself (assuming that no mutations occur; see below). Each cell of a higher organism is composed of a jellylike layer of material, the cytoplasm, which contains many small structures. This cytoplasmic material surrounds a prominent body called the nucleus. Every nucleus contains a number of minute, threadlike chromosomes. Some relatively simple organisms, such as bacteria, have no distinct nucleus but do have cytoplasm, which contains one or more chromosomes. Chromosomes vary in size and shape and, in the nucleus, usually occur in pairs. The members of each pair, called homologues, closely resemble each other. Most cells in the human body contain 23 pairs of chromosomes, whereas most cells of the fruit fly Drosophila contain four pairs, and the bacterium Escherichia coli has a single chromosome in the form of a ring. Every chromosome in a cell is now known to contain many genes, and each gene is located at a particular site, or locus, on the chromosome. The process of cell division by which a new cell comes to have an identical number of chromosomes as the parent cell is called mitosis (see Reproduction). In mitotic division each chromosome divides into two equal parts, and the two parts travel to opposite ends of the cell. After the cell divides, each of the two resulting cells has the same number of chromosomes and genes as the original cell (see Cell: Division, Reproduction, and Differentiation). Every cell formed in this process thus has the same array of genetic material. Simple one-celled organisms and some multicellular forms reproduce by mitosis; it is also the process by which

complex organisms achieve growth and replace worn-out tissue. Higher organisms that reproduce sexually are formed from the union of two special sex cells known as gametes. Gametes are produced by meiosis, the process by which germ cells divide. It differs from mitosis in one important way: In meiosis a single chromosome from each pair of chromosomes is transmitted from the original cell to each of the new cells. Thus, each gamete contains half the number of chromosomes that are found in the other body cells. When two gametes unite in fertilization, the resulting cell, called the zygote, contains the full, double set of chromosomes. Half of these chromosomes normally come from one parent and half from the other. The Transmission of GenesThe union of gametes brings together two sets of genes, one set from each parent. Each gene--that is, each specific site on a chromosome that affects a particular trait--is therefore represented by two copies, one coming from the mother and one from the father (for exceptions to this rule, see Sex and Sex Linkage, below). Each copy is located at the same position on each of the paired chromosomes of the zygote. When the two copies are identical, the individual is said to be homozygous for that particular gene. When they are different--that is, when each parent has contributed a different form, or allele, of the same gene--the individual is said to be heterozygous for that gene. Both alleles are carried in the genetic material of the individual, but if one is dominant, only that one will be manifested. In later generations, however, as was shown by Mendel, the recessive trait may show itself again (in individuals homozygous for its allele). For example, the ability of a person to form pigment in the skin, hair, and eyes depends on the presence of a particular allele (A), whereas the lack of this ability, known as albinism, is

caused by another allele (a) of the same gene. (For convenience, alleles are usually designated by a single letter; the dominant allele is represented by a capital letter and the recessive allele by a small letter.) The effects of A are dominant; those of a, recessive. Therefore, heterozygous persons (Aa), as well as persons homozygous (AA) for the pigment-producing allele, have normal pigmentation. Persons homozygous for the allele that results in a lack of pigment (aa) are albinos. Each child of a couple who are both heterozygous (Aa) has a probability of one in four of being homozygous AA, one in two of being heterozygous Aa, and one in four of being homozygous aa. Only the individuals carrying aa will be albino. Note that each child has a one-in-four chance of being affected with albinism; it is not accurate to say that one-quarter of the children in a family will be affected. Both alleles will be carried in the genetic material of heterozygous offspring, who will produce gametes bearing one or the other allele. A distinction is made between the appearance, or outward characteristics, of an organism and the genes and alleles it carries. The observable traits constitute the organism's phenotype, and the genetic makeup is known as its genotype. Not always is one allele dominant and the other recessive; instead, the inheritance of both sometimes results in intermediate characteristics. The four-o'clock plant, for example, carries flowers that are red, white, or pink. Plants with red flowers have two copies of the allele R for red color and hence are homozygous RR. Plants with white flowers have two copies of the allele r for white color and are homozygous rr. Plants with one copy of each allele, heterozygous Rr, are pink--a blend of the other two colors. The action of genes is seldom a simple matter of a single gene controlling a single trait. Often one gene may control

more than one trait, and one trait may depend on many genes. For example, the action of at least two dominant genes is required to produce purple pigment in the purple-flowered sweet pea. Sweet peas that are homozygous for either or both of the recessive alleles involved in the color traits produce white flowers. Thus, the effects of a gene can depend on which other genes are present. Quantitative InheritanceTraits that are expressed as variations in quantity or extent, such as weight, height, or degree of pigmentation, usually depend on many genes as well as on environmental influences. Often the effects of different genes appear to be additive--that is, each gene seems to produce a small increment or decrement independent of the other genes. The height of a plant, for example, might be determined by a series of four genes: A, B, C, and D. Suppose that the plant has an average height of 25 cm (10 in) when its genotype is aabbccdd, and that each replacement by a pair of dominant alleles increases the average height by approximately 10 cm (about 4 in). In that case a plant that is AABBccdd will be 46 cm (18 in) tall, and one that is AABBCCDD will be 66 cm (26 in) tall. In reality, the results are rarely as regular as this. Different genes may make different contributions to the total measurement, and some genes may interact so that the contribution of one depends on the presence of another. The inheritance of quantitative characteristics that depend on several genes is called polygenic inheritance. A combination of both genetic and environmental influences is known as multifactorial inheritance.