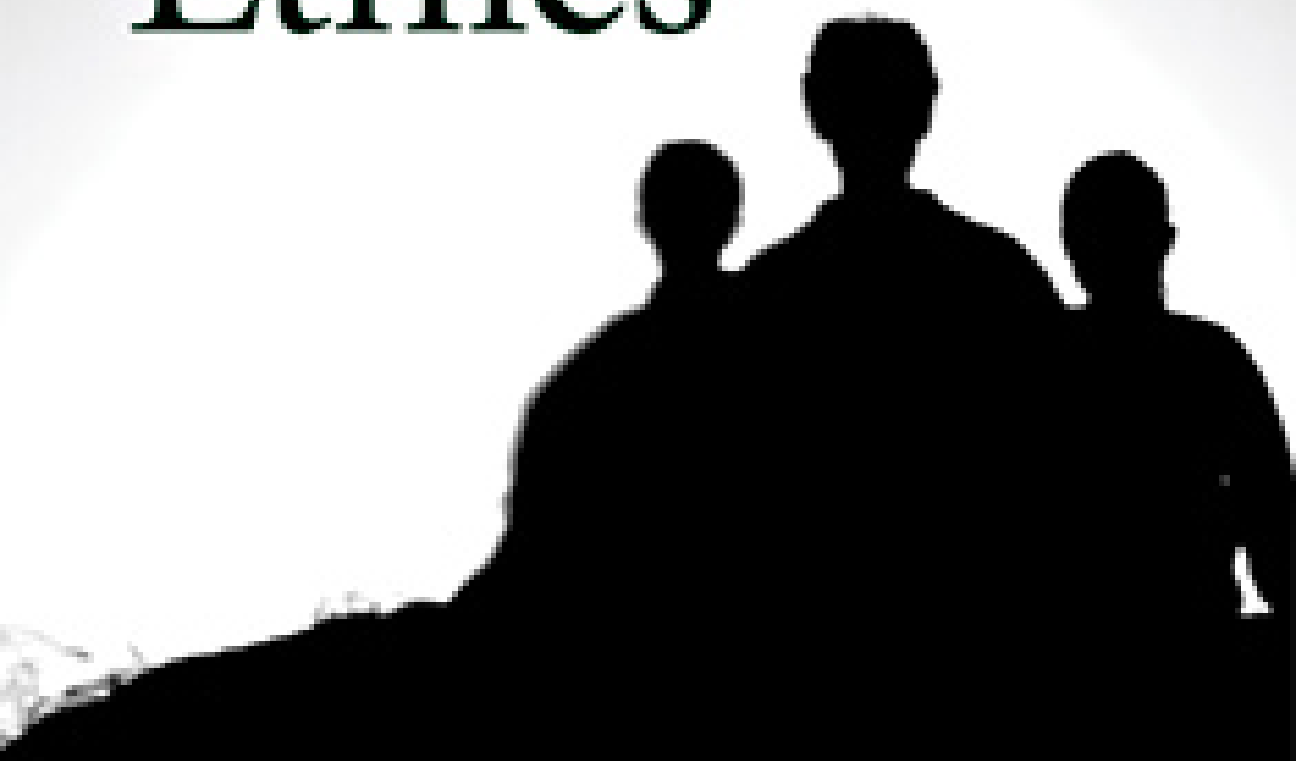
Bioscience Ethics



IRINA POLLARD

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Bioscience Ethics

Bioscience ethics facilitates free and accurate information transfer from applied science to applied bioethics. Its major elements are: increased understanding of biological systems, responsible use of technology, and curtailment of ethnocentric debates more in tune with new scientific insights. Coined by Irina Pollard in 1994, bioscience ethics has become an internationally recognized discipline, interfacing science and bioethics within professional perspectives such as medical, legal, bioengineering and economics. The fundamental feature of this book is its breadth, which is important because bioscience ethics interweaves many diverse subjects in the process of gathering specialist scientific knowledge for bioethical review. It contains chapters which embrace topics affecting human reproduction, end-of-life care and euthanasia, others which challenge human-dominated ecosystems, and review population growth, economic activity and warfare. A background section describes the evolution of ethical consciousness, explores the future and proposes that the reworking of ethical boundaries can enhance mature decision-making in harmony with changing technology.

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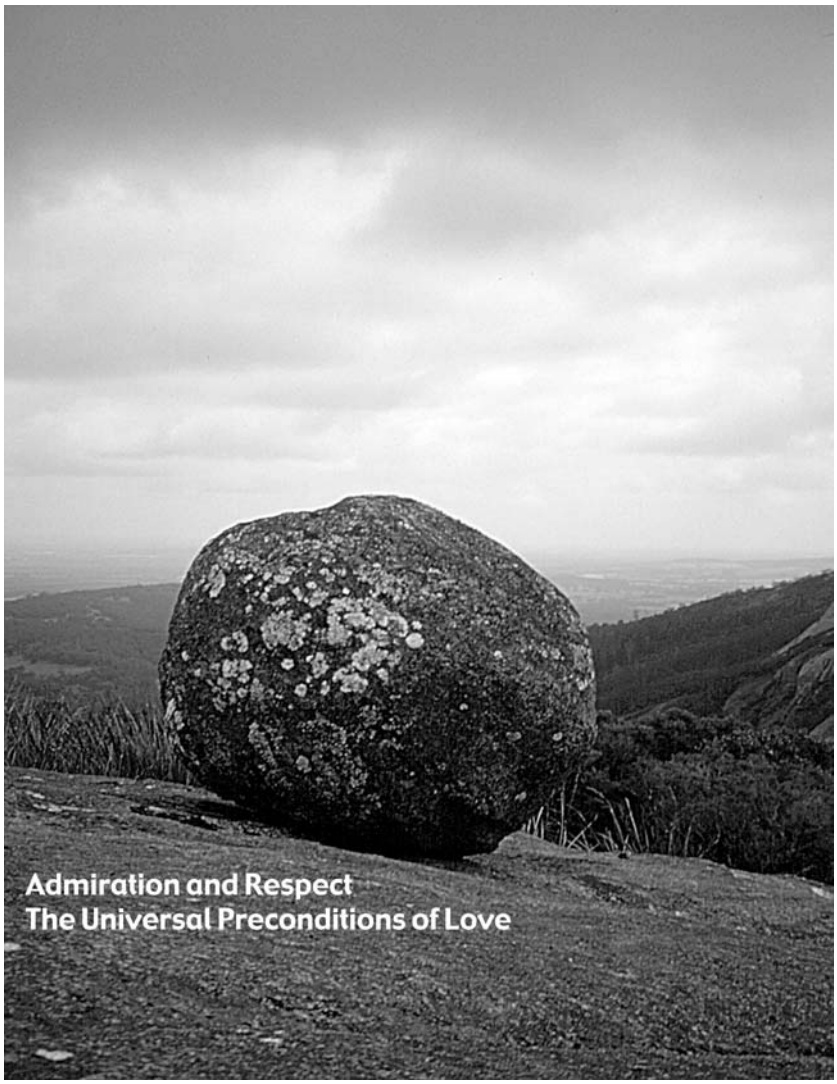
Admiration and Respect
The Universal Preconditions of Love

Bioscience Ethics

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Contents

5

Fertility awareness: the ovulatory method of birth control, ageing gametes and congenital malformation in children

> Procreation in our species is so haphazard that only in the last few decades [have] people started to pay attention to the intact and potentially perfect survival of the offspring. Previously, it was considered an Act of God that carried off a large number of the infants born alive and left many of the rest permanently damaged. Only in this century have people started to question such a fatalistic approach and look to ways of reducing perinatal mortality and morbidity.[1]

The previous two chapters reviewed common biological mechanisms linking stressful lifestyles, drug abuse and significant increased risk of serious structural and/or functional anomalies in the offspring. It was also emphasized that drug abuse, being predominantly a consequence of poverty, social alienation and biological ignorance, is a matter of personal and collective responsibility. A judgemental attitude is not an effective method of reducing preventable disability in children – raising standards of living and providing the empowering qualities of high-calibre education is much more effective. The present chapter provides information about fertility and ageing gametes, and promotes increased awareness about possible relationships between 'natural family planning' methods of contraception and pregnancy outcomes.

Fertility awareness is far more than just the accumulated basics of the reproductive process. Fertility awareness involves being knowledgeable about

[1] Chamberlain, G. & Lumley, J. (eds) (1986). *Prepregnancy Care: A Manual for Practice*. Chichester, UK; John Wiley & Son, p. 1.

the physiology of reproduction, applying that knowledge to oneself and one's partner, and then making informed decisions concerning the timing of intercourse and understanding how each contraceptive method interrupts fertility and how that method may fail if not used correctly. Fertility awareness information is necessary both to plan pregnancies as well as to avoid them. Couples who plan their pregnancies, as compared with unplanned conceptions, have fewer complications during pregnancy and better pregnancy outcomes. This reinforces a social obligation to officially promote sex and relationship education in the school curriculum. All citizens, but especially the young, should be appropriately educated about reproductive processes and protected from misinformation. In this context, however, there are many important social, cultural and religious taboos which effectively prevent the acquisition of significant biological information that sustains universal reproductive health needs. Alarmingly, the revision of bioethical discourse is more often obstructed when the discussion revolves around human sexuality and reproduction, seriously threatening this area of health education. From the ethical perspective, inappropriate behavioural directives may be understood as a transgression of the duty of care. Bioscience ethics affirms the human right of access to comprehensive, high-quality and updated scientific information so that knowledge may be applied under varying social conditions. However, before an analysis of common behavioural directives in matters of sexuality is undertaken, a brief precis of basic principles of genetics may be useful.

The laws of inheritance

The adult human body is made up of more than one hundred trillion (10^{14}) different cells which perform specific functions, and the genes provide instructions for how each cell should effectively operate. As described in Chapter 2, genes and epigenetic variables provide the basis of growth and development; that is, from fertilization through to adulthood and death, the information necessary for the daily maintenance and functioning of our bodies is organized. All cells typically contain a full set of genes; however, within any particular cell type it is only those genes which are relevant to performing the cell's specific task that are expressed, or switched on.

Genes are sections of DNA (deoxyribonucleic acid) which are contained in the chromosomes passed on from our parents at conception. Typically, human somatic cells have two sets, or 23 homologous pairs, of chromosomes, making 46 in total. These 46 chromosomes contain two sets of genes; one set inherited from our biological mother and the other from our biological father. The germ

cells are exceptional in that they develop into gametes, either sperm or eggs, each carrying only one set of 23 chromosomes in total. The single set of chromosomes in the egg or sperm cell is a unique recombination of maternal and paternal genetic material. Recombination, or the process of crossing over, is a key event that involves physical exchanges between chromosome pairs and provides the mechanism that promotes genetic diversity among the resulting gametes. At fertilization the full complement of 46 chromosomes is restored, resulting in an equal contribution of genetic material from each parent except for the pair of sex chromosomes. All eggs carry an X chromosome (one of the mother's two X chromosomes), but a sperm cell may carry either an X or a Y chromosome. Since the mother always passes on an X chromosome, the sex of the child is determined by the father. At fertilization, a sperm bearing an X chromosome makes XX or a girl, and a sperm bearing a Y chromosome makes XY or a boy.

The intricate mechanism that copies the genetic material in preparation for cell division is mitosis, which produces exact copies of the nucleus. A drawback of mitotic (asexual) reproduction is its very uniformity as it leads to the production of a clone of genetically identical progeny. Although the clone may be well adapted to its existing environment, it may be at real risk should conditions change. In contrast, organisms that produce genetically different offspring are more successful when the environment varies unpredictably in time and space – at least some of their genetically diverse offspring may be able to meet the challenges of a changing environment. Diversity is fostered by sexual reproduction; that is, by the production of gametes containing a single set of chromosomes. The mechanism for nuclear division, which reduces the chromosome number and ensures genetic diversity among the products, is called meiosis. When meiosis is complete, it is very unlikely that any two human gametes will have the same combination of homologous chromosomes.

The DNA molecule consists of a double-stranded helix with each strand held together by a bonding between pairs of four possible nitrogenous bases called adenine, thymine, cytosine and guanine (abbreviated A, T, C and G). The information content of DNA is given by the order in which these bases occur along the DNA molecule. Genetic information, as passed through the generations of cells, is complex and sophisticated, but an often-used analogy to illustrate the relationship between genes, DNA and chromosomes has proved helpful. A chromosome can be compared to an audiocassette, DNA to the tape inside the cassette, and genes to the songs on the tape. Genes are not separate from DNA but are an integral part of it just as the song is an indivisible part of the tape.

Human fecundity

As we have seen in Chapters 3 and 4, genetic information can be passed on to the next generation erroneously, resulting in faulty, mutated genes. The majority of common disorders, such as heart disease, diabetes and cancer, however, are caused by a combination of genetic and environmental factors, and are said to be multifactorial in origin. A variety of stresses, including ageing, may cause mutations either early during the division and differentiation of germ cells or later in development. Mutations can occur where one or more entire chromosomes or parts of chromosomal material are either lacking or present in excess, a condition known as aneuploidy. Aneuploidy usually results in a specific malformation and/or severely restricted overall growth of the fetus. Children with Down's syndrome, for example, have an extra copy of chromosome 21. At birth, approximately 5% of humans have a significant or serious congenital abnormality. Half of these defects involve chromosome imbalances; the other half involve complex congenital abnormalities and common diseases caused by single-gene defects. Despite their importance from the clinical, economic and social perspectives, these surviving cases represent just a small fraction of those present in early developmental stages. The truth is that the human fecundity rate (that is, the probability of achieving a clinically recognized pregnancy within any given menstrual cycle) is about 25%, and high levels of fertilization failure or early developmental death are the norm. This high attrition rate is due to abnormalities in the gametes and faulty development, leading to embryo death prior to implantation.

Scientists arrive at fertility estimates by studying large cohorts of fertile women who are attempting to conceive, and from these studies it is clear that humans are unique in the very high frequency of chromosome abnormalities and consequent early embryo wastage. Clinically recognized pregnancy loss, on the other hand, is usually quoted as 15–20%. It is this clinical fraction of failed pregnancies that has been extensively studied cytogenetically and in which a chromosome abnormality rate of at least 50% has been established. This contrasts markedly with a 5% chromosome abnormality rate found in stillbirths, illustrating clearly the natural in utero selection process that eliminates 95% of chromosomally unbalanced conceptions. Figure 5.1 assigns categories of known and unknown human anomalies at birth. It can be seen that 50–60% of developmental anomalies at birth are of unknown aetiology, while known causes can be assorted into chromosomal aberrations, mutant genes and environmental factors. Of the known categories, 20–25% are

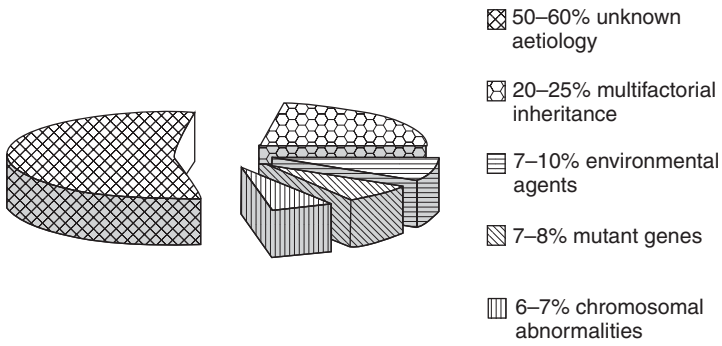

Figure 5.1 Causes of human congenital abnormalities at birth. (Reproduced from Pollard, I. (2006). Lifestyle and fertility. In D. Macer (ed.) *A Cross-Cultural Introduction to Bioethics*. Christchurch, New Zealand: Eubios Ethics Institute, Fig. 1, p. 193, with permission.)

multifactorial inheritances. Prenatal diagnosis such as amniocentesis, chorionic villus sampling and preimplantation genetic diagnosis (which may result in voluntary pregnancy termination), can thus be seen as a medical extension of this natural process.

Female libido: procreational versus recreational sex

The human is an extraordinary species, with freedom to deviate from strict stereotypical behaviours, especially sexual. Most mammals are sexually receptive only when fertile, whereas the human female's potential for sexual arousal and orgasm at all times in the menstrual cycle is no secret. To achieve sexual independence from fertility, however, Nature had to invent a new strategy. The solution was to transfer the physiological control of libido from the female sex hormones (estrogens and progesterone) involved in ovulation and pregnancy, to another set of hormones, in this case the androgens testosterone and androstenedione. A woman's complement of androgens, derived from her ovaries and adrenal glands, keep her sexual drive active throughout the menstrual cycle. The advantages of retaining sexual receptivity at all times, including those when conception is not a physiological option, is obvious. Such a strategy clearly helps to maintain long-term relationships. It is an evolutionary device to maximize parental care of the young and provide sexual pleasure and comfort for the highly sexed human being. Early human societies throughout the world understood this and developed many ways of thoughtfully preventing unwanted conceptions.

Since we have evolved into an extremely socialized species, sexual intercourse has a greater significance than the mere transmission of the genotype. As already alluded to above, sexual pleasure is particularly important, but continued sexual receptivity favours pair bonding, essential for the maintenance of long-term relationships and the raising of offspring. Cooperative living reinforces self-sufficiency and wellbeing and for that reason helps in raising the offspring. Other aspects can also be identified; sexual behaviour may be used to establish dominance in relationships, express hostility or be used for material gain. It is clear that the sociobiological functions of human sexuality go far beyond reproduction and pair bonding. They influence the shaping and linking of groups of individuals into communities and communities into societies; that is, in anthropological terms, the humanizing of biological relationships. Procreational sex, in becoming recreational sex, also became the glue of society. Nature has taken care of our ongoing fitness by providing behavioural flexibility. So, who are we – especially in our present state of biological ignorance – to ethically question the logic of our evolutionary heritage? Certainly we cannot pontificate about what is 'natural' and what is not, before we have become a good deal more knowledgeable about our uniquely human heredity.

Principles of reproductive ageing

In a system where sex can be separated in time from ovulation, aged/defective sperm, eggs and conceptuses are a natural byproduct. Flexible sexual behaviour results in genetic wastage, which is adaptive and balances evolutionary-directed change in behaviour. Nature's solution is to provide high-quality fertility by an excess of potential with the intention that only a small proportion of that potential will ever be realized. Because of the ease in achieving fertilizations (as demonstrated by in vitro fertilization technology), embryo wastage is high in humans; however, severe chromosomal abnormality in the conceptus ensures the natural discontinuance of such pregnancies. Specifically, spontaneous abortion is Nature's way to counter environmental factors which exert an important influence on ageing processes of gametes and conceptuses. This explains the low percentage of all human fertilizations which survive to birth, with a large majority of these lost in the very early stages of pregnancy. Similar reasoning can also be applied to fertility; that is, gamete wastage prior to fertilization. In fertile men, the sperm concentration varies between 60 and 80 million active sperm per millilitre of semen in an ejaculate volume of approximately 2.5–3.5 ml. Despite the fact that each active sperm (given the chance) is a potential person, the turning

point between fertile and infertile sperm number is approximately 20 million active sperm per millilitre (Chapter 9).

Ageing can be defined as the decline in body functions with time associated with a reduced capacity to maintain control of the body's basic stability, or homeostasis. Many theories have been developed to explain the causes of ageing, but it is doubtful that any one theory is adequate to explain the entire ageing phenomenon. Investigators do agree, however, that the genome has a major role in determining the maximum length of the lifespan, with environmental factors exerting an ongoing influence on ageing processes. In women, cyclic and orderly changes in ovarian function during the normal menstrual cycle are closely timed and regulated by the actions of the brain, particularly the hypothalamus and the pituitary gland. In turn, steroid hormones (estradiol and progesterone) produced by the ovary modulate hypothalamic and pituitary function through feedback mechanisms. Follicular growth and steroid hormone secretion are controlled by the two pituitary gonadotrophins – follicle stimulating hormone (FSH) and luteinizing hormone (LH). FSH stimulates follicle development, growth and estrogen synthesis, while LH stimulates progesterone secretion and prepares the dominant follicle for ovulation. Thus, at mid-cycle, the preovulatory LH surge is followed, about 38 hours after its onset, by ovulation. At least this is the simplified textbook story. Recently, ultrasound scans have demonstrated that women may ovulate more than once per menstrual cycle, which may result in ovulation on separate days. They may experience two and three follicular growth waves per menstrual cycle with any, or none, resulting in ovulation. It has been estimated that double ovulations separated in time may account for 10% of fraternal twinning.

As with all complicated physiological functions, oocyte maturation during peak LH levels consists of a series of events occurring between 4 and 38 hours after the onset of the LH surge. After ovulation, also under LH action, the ruptured follicle is luteinized to form a corpus luteum which secretes hormones preparing the uterine endometrium for implantation of the embryo. The period between ovulation and fertilization, likewise, consists of important temporal maturational and ageing processes. Following fertilization and implantation, human chorionic gonadotrophin (hCG) produced from early placental tissue prevents the corpus luteum from regression so that pregnancy can be established. However, if implantation is not successful, menstruation occurs and the cycle is repeated.

The average age at which a woman goes through the menopause is 49–52 years, and the most dramatic event associated with the menopause is the loss of cyclic ovarian function and cessation of menstrual cycles. The number of follicles in the ovaries of a healthy young woman is estimated to be 400 000,

but only an estimated 0.1% is actually involved in ovulatory function, while the remainder degenerate during the reproductive years.

Ageing in men is subtler than in women, as men often remain fertile into old age, but there is a parallel reproductive decline in testicular function with age. Testosterone secretion and spermatogenesis decreases. While sperm number may remain relatively high in healthy older men, degenerative changes are observed in the germinal tubular membrane, due to sclerosis and closing of the tubular lumen. Consequently, there is an age-related reduction in the daily production of sperm, the number of normal sperm and the conception rate. Most de novo mutations causing inherited disease are paternal in origin. Sperm vulnerability is thought to be related to fundamental differences between spermatogenesis and oogenesis. Early in gametogenesis (the production of gametes), the numbers of primordial germ cells increase by mitosis. In the female, this mitotic expansion continues until late in gestation when the germ cells (oogonia) enter meiosis and remain arrested (now primary oocytes) until years later when ovulation occurs and the oocytes are stimulated to resume meiosis. It is significant that this pool of non-growing primary oocytes represents the sole source of unfertilized eggs in the sexually mature female and is the link with the next generation. In the male, mitotic division of germ cells (spermatogonia) begins at puberty and continues actively throughout life. Thus the risk of replication errors preceding spermatogenesis increases with advancing age.

It is important to note that paternal-mediated contributions to birth defects (as demonstrated by fetal death rates and genetic abnormalities in offspring) increases sharply with paternal age. Fathers above 39 years of age have an elevated risk of having a Down's syndrome offspring, with a strong effect from the age of 41. One of the most comprehensive studies in this field is from the French Medical Research Agency, using coordinated data from 22 fertility clinics across the nation. This calculated the percentages of babies with Down's syndrome according to the age of the sperm donors. The results showed that 0.14% of the children born to fathers under 35 had Down's syndrome compared with 0.23% of babies born to men aged between 35 and 39, and 0.41% born to men over 39 – an almost threefold increase over those in the youngest age group. Other investigations have revealed a strong correlation between paternal age and increased risk for neurodevelopmental anomalies such as schizophrenia and autistic spectrum disorders. Fathers aged between 45 and 49 years were twice as likely to sire a child with schizophrenia and three times as likely if over 50 years of age. Since a male biological clock definitely exists, some sperm banks cut off donations at the 35th birthday, while others cut off sperm donations at the 30th birthday. The above data, equating advanced

paternal age with increased risk of genetic disorders, reinforces the view that fathers have a very personal responsibility toward their unborn children.

There is a risk, however, that too much emphasis is placed on genetic explanations for illnesses so that we begin to see ourselves simply as the sum of our genes. This attitude is known as genetic determinism and is dangerous, as an overemphasis on genetic explanations can undermine the assumption of personal responsibility for our actions. It may even be used to justify antisocial or unhealthy behaviour (belief in a 'master' race, for example). Congenital anomaly is not determined solely by genetic factors, but by a complex interaction of genes, teratogens, environmental and behavioural variables.

Ageing gametes and ovulatory method of birth control

Culture is a potent factor affecting our biology, just as biological factors put constraints on culture. During the hunting and gathering phase of human history there existed millions of years of equilibrium between a nomadic, small community lifestyle and continuity in terms of a balanced interaction with the environment. With the domestication of plants and animals in the Neolithic era (beginning around 10 000 BCE), however, came a radical change in subsistence activities and a more restricted interaction developed between humans and their environment. Social aggregations of people brought about by farming and the manufacture of technologically advanced stone implements made it imperative to invent new restrictions and laws. Increased social regulation had to follow increasing sedentism and the aggregation of larger populations which were now at greater risk of poorer hygiene and disease. Thus, new sociobiological rules developed to make the sedentary, village lifestyle more manageable and healthier. Since the scientific revolution, however, human knowledge has expanded and it is again a good time to reassess our social mores adaptively. Taking into consideration new scientific insights, we may be able to keep what is biologically relevant and makes adaptive common sense, and modify what is not – in other words, respond to the objectives of bioscience ethical thinking.

There has always been a need to control human fertility. Prevention of unwanted pregnancy dates back over 4000 years with successive ancient civilizations recording recipes for abortifacients, vaginal pastes and medical tampons. Modern insights connecting sex and sexually transmitted disease probably dates from the use of the linen sheath in 1564 as protection against syphilis. Now, as never before, because of population expansion, diseases such as AIDS and widespread poverty, human society needs ready access to safe, effective, reversible and affordable methods of contraception. Modern

contraceptives provide personal empowerment, whether this is for the protection of health or family planning by number and spacing of children. However, countless women still needlessly die every year, or suffer from debilitating ill health as a result of complications of pregnancy, with the majority – but not exclusively – in the overpopulated developing world. Effective contraception also reduces the incidence of high-risk, unsafe abortions and what this means in terms of human suffering. As we have learned earlier, all methods of contraception are natural in the biological sense since all humans can do is to embellish the sexual benefits already inherent in Nature's creativity.

Contraceptive approaches that rely on coital technique, rather than on the use of technical or pharmaceutical aids, are generally referred to, in common parlance, as 'natural' methods. To the lay person, the ovulatory method of birth control (or natural family planning if you like) equates with the 'rhythm' method and relies on periodic abstinence intended to coincide with the time surrounding ovulation. To be effective, the ovulatory method of birth control depends on the woman being able to detect her fertile time. This is done by estimating the number of days from the commencement of menstruation to the beginning of fertility or, more accurately, by measuring her basal body temperature (a small rise in basal body temperature of 0.2–0.6°C occurs post-ovulation), examining the consistency of her cervical mucus, or by variable combinations of all these methods.

Ovulation detection by measuring basal body temperature is a retrospective approach and will only be safe if the woman's cycle is sufficiently constant from month to month. Given the menstrual cycle's susceptibility to emotional or stressful disturbances, it often is not. Under the grip of intense emotion, it is also possible for ovulation to be induced by intercourse, as has been demonstrated in rape victims. Other difficulties of the rhythm method are the requirement for high motivation and cooperation by both partners. In summary, therefore, 'safe period' predictions are unreliable, as confirmed by the rhythm method's failure rate of between 2 and 24% in the first year (some 20-fold less effective than oral contraceptives at their worst). To improve on this method's effectiveness, sexual intercourse should be avoided through much of the first part of the cycle; this takes into consideration the potential life of spermatozoa in the cervix (of several days) and a 24–36-hour life of the oocyte(s), which may not necessarily arrive at the expected time. Given these cycle variables, conceptions resulting in unwanted pregnancies are realistic options and are, presumably, considered as acceptable 'chance' failures.

Because of the rhythm method's cheapness, there has been increasing pressure since the 1990s to make it a suitable contraceptive choice in the developing, overpopulated world, where natural family planning is the sole

method of fertility control for some of the world's poorest couples. It is true that natural family planning allows couples to avoid, or achieve, pregnancy. Those wishing to achieve a pregnancy will have extremely high pregnancy rates, while those strongly motivated and understanding the practicalities underpinning the method can enjoy extremely low pregnancy rates. However, it is in the interest of couples, and the society in which they are living, to be educated and unambiguously informed about the relative risks and benefits of competing artificial contraceptives relative to natural family planning. Major concerns are unwanted pregnancies, fertilizations with aged gametes resulting in possible genetic defects and growth anomalies, and exposure to sexually transmitted diseases. Individuals and couples deserve to be provided with the latest available scientific information if they are to make informed decisions about their sexuality.

In the event that natural family planning is chosen, then the women concerned should expect to be given clear guidelines as to how to recognize indirect symptoms of ovulation accurately, so that the possibility of becoming pregnant is minimized. The cervical mucus test (or Billing's method) is effective but not infallible. Cervical mucus changes its consistency according to the hormonal balance between estradiol and progesterone. Under estrogen domination, around the time of ovulation, cervical mucus is composed of parallel chains of fibrils with sufficient space between them to permit the passage of sperm. At other times, cervical mucus is thicker and lacks the micellar structure, making it an effective barrier to the entry of sperm and bacteria. However, as for all bodily functions, the physiological changes are not abrupt but progress gradually according to a predetermined series of events. Thus, as the estrogen levels begin to rise, driving the approaching ovulation, sperm passage may no longer be completely blocked, allowing some to shelter in storage crypts at the upper end of the cervix where they are sealed in by a mucus plug. Just before ovulation the mucus plug dissolves, releasing the trapped sperm from the cervical crypts, facilitating their further passage towards conception.

With the development of new technology to both predict and to detect ovulation, 'fertility awareness' contraceptive methods may become more reliable in the future. The already marketed but expensive *Persona* is a small hand-held electronic computer and urine testing device. The idea is that the device attempts to predict ovulation by initially measuring the sharp rise of estrone-3-glucuronide, a urinary metabolite of estradiol, to establish a personal menstrual profile. Then, in subsequent cycles, the device warns the woman, through a red light, that she is entering her predicted fertile period. From the

main European clinical trial the failure rate among consistent users was 6% in any one year – not an encouraging result.

The gametopathy hypothesis and congenital anomalies

It was back in the 1970s when Piet Jongbloet and colleagues first published data demonstrating that the incidence of Down's syndrome amongst Roman Catholic women living in Western Australia was more than double that in all other religious groups. During the same decade, the Dutch Ministry of Health reported a similar difference in Down's syndrome incidence between Catholic and other religious groups from every province in the Netherlands. Work from other countries, similarly, described a Catholic over-representation in a variety of congenital anomalies, including oral cleft lip–palate defect, spina bifida, anencephaly, low birthweight and psychological/neurological abnormalities. These findings raised concern about method failures associated with natural family planning, where conceptions due to intercourse before the fertile period could arise from aged sperm, and conceptions after the fertile period could occur with a post-ovulatory aged ovum. This was of particular interest since the 'ovulation' method of birth control had been encouraged among the Catholics in Australia where there was a strong correlation between contraceptive practice and religious affiliation. It was also reported that women delivering an oral cleft infant were three times as likely to have used the rhythm method for contraceptive purposes at the time of conception, compared with women delivering healthy babies. That corticosteroids and their chemical byproducts are incompatible with good reproduction has been known for a long time and, evidently, an unwanted pregnancy is a stressful life event. It has also been known for a long time that the primary defect induced by excess concentrations of circulating corticosteroids is cleft lip-palate, demonstrable in all species. Since the publication of Jongbloet's early reports, the identification of reproductive dysfunction has widened to include a range of abnormalities of the placental unit as well as the embryo. Placental anomalies may lead to pregnancy and birth complications, while the embryonic anomalies may be observed as developmental abnormalities.

The above, initially perplexing, observations have now been defined in biological terms, as follows. During irregular menstrual cycles when spontaneous ovulation occurs earlier or later than estimated, the prescribed sexual abstinence does not precisely coincide with peak fertility; that is, the synchronous presence of fresh gametes at the fertilization site. Desynchronized ovulation and fertilization may facilitate the union of over-ripe ova, surviving

aged sperm, or a combination of both. That is, in the case of an unplanned conception, the rhythm method prolonged the post-ovulatory delay beyond the optimum before fertilization took place, compared with instances of continuing intercourse during the mid-cycle. Nevertheless, risk estimates derived from unconfirmed studies must be interpreted with caution as there is always the problem of ascertaining whether a conception arose from aged gametes or other confounding effects. There is also the potential for bias in maternal recall. However, the gametopathy hypothesis is supported by animal experimentation, where delayed ovulation and fertilization increases the risk of a continuum of anomalies; some are developmental, while others are associated with chromosomal aberrations and mutations. Delayed fertilization in the rat and rabbit, for example, is associated with intrauterine growth retardation (IUGR), developmental abnormalities and increased embryo mortality in post-implantation conceptuses, clearly demonstrating that non-optimum fertilization is one source of reproductive wastage.

Ovopathy and spermopathy may be evoked by a series of physiological disturbances of the ovulation and fertilization system, not all connected with a failure of the rhythm method of contraception. Such conditions may include advanced parental age, poverty and decreased frequency of sexual intercourse. It is worth noting, however, that the suggested causal relationship between contraception failure and the birth of infants with pathological conditions, especially cleft malformations, has decreased in industrial societies following the use of modern, effective contraceptives which result in reduced numbers of unplanned pregnancies. Since its early documentation and as new evidence has accumulated, the gametopathy concept has gained credibility in reproductive biology, and is currently being integrated into standard manuals of obstetrics. With this in mind, the present is an opportune time to extend the scientific ethical engagement by debating bioethical concerns in relation to currently acceptable norms of human sexual behaviour.

As described above, human beings are unique in the very high frequency of chromosomal abnormalities and embryo wastage. Of the 50–60% unexplained developmental anomalies (see Fig. 5.1), it is entirely possible that a proportion of these represent fertilization of old, past their 'due date' gametes. It follows, therefore, that influencing human sexual behaviour through health care programmes for avoiding non-optimum conceptions can prevent many pathological conceptions. If the public were to be given better information about the ovulatory cycle and contraceptive methods, the conception of wanted children would occur under optimum physiological conditions. Such health care programmes can readily be incorporated into general education programmes and are much more humane than alternative and expensive prenatal (that is,

post-conception) diagnoses, such as amniocentesis that may lead, in the event of a positive identification of genetic abnormality, to the necessity for traumatic parental decisions to be made.

It may be appropriate at this point of the discussion to quote from contemporary Catholic aspirations: 'In order for the kind of openness to life described by Humanae Vitae to cut through the contraceptive mentality that permeates American culture, many experts agree that more medical professionals must be brought to see NFP (natural family planning) as at least a valid, if not preferable, alternative to artificial birth control.'[2] From the biological perspective, however, can the rhythm method of contraception be accepted as being more natural than the use of alternative forms of birth control? It is certain, in this instance, that the medical profession has to be vigilant not to succumb to influences which may violate the doctor's ethical obligation not to cause harm.

For millions of people, in particular those living in poverty in overpopulated developing countries, the promotion of the Catholic Church's teaching is an important part of their life's work. At the same time, women in those corresponding developing countries suffer considerable morbidity and mortality because of their inability to control their own fertility. Maternal mortality related to pregnancy or delivery is now estimated to be around 529 000 each year, with an estimated further 10 million women a year suffering from related complications.[3] Unsafe abortions account for between 25 and 40% of the mortality, with an overall two-thirds of the deaths being preventable, if contraceptives were provided and family planning services dealt comprehensively with women's health issues. There can be no ethical defence of the systematic denial of the right of freedom from excess fertility, condemning so many innocent women and their children to a life of illness and poverty, and often death. Yet these horrendous figures serve to highlight the failure of political, religious, health and legal institutions to address the most fundamental injustice of our time. Women must urgently be given the responsibility to decide whether, how and when to have children, and the right to information and services necessary to exercise that responsibility. To do less is a gross denial of the freedom from excess fertility, referred to in free societies as the fifth freedom, developed along the lines of the other four fundamental freedoms; that is, freedom of speech, freedom of worship, freedom from want and freedom from fear.

[2] 30 years after *Humanae Vitae*. (1998). *Catholic World Report*, **8**, 55.

[3] Maternal mortality – estimates developed by WHO, UNICEF and UNFPA. See http://www.who.int/reproductive-health/publications/maternal mortality 2005/index.html..

Men are also not getting just treatment. Potential fathers are often excluded from reproductive health care and, typically, are not sufficiently informed about the menstrual cycle and the need for conception to occur under optimal physiological conditions to maximize the probability of the offspring expressing its full genetic potential. For example, there are not many parenting workshops for men, and even fewer on male sexuality and probably none on male responsibility, the last especially being pressing as women do not make sexual/reproductive decisions on their own. Without the involvement of couples and without a revolution of openness in considerations of sexuality, society cannot expect to overcome the health challenges and conquer the population crisis.

How can it be then, from the point of view of one of the world's most powerful religions, that the rate of reform is so disconcertingly slow? The path of directives, as they move from the actual encyclical, through the bishops, to the diocesan marriage preparation programmes, to the natural family planning teachers, to the priests and seminarians and, finally, ending with the individual married couples, is twisted and long. Given this tortuous path, it is appropriate to ask how biological teaching and understanding is preserved. The Church states that periodic continence shows due respect for the Church's moral law, but does the denial of responsible control over one's own reproductive and sexual health accord due respect for biological law, and does it justify the additional risk borne by the next generation of children? In civil societies, each individual is expected to be responsible for matters of conscience and, in turn, society has a responsibility to protect and teach its citizens that the creation of new individuals is a privilege. Thus, parental sexual behaviour, as well as other lifestyle variables such as drug consumption, should be part of the continuing educational process. It is ethically unacceptable for us to stand idly by and watch the hard-earned demographic shift of birth rate decline, caused by growing prosperity and female literacy, be ruthlessly overturned by unqualified directives.

Family planning education in a number of developing countries has become an underground movement as a result of Church leaders inveighing against contraception, and inspiring fear among politicians who may want to, contrary to the religious demands, promote individual choice in matters of reproduction. The Philippines, for example, has a fertility rate of 3.05 children per woman (2007 estimate) and an estimated one-fifth of 15–24-year-old girls have had an illegal abortion; or every year about 750 000 women undergo an induced abortion in illegal clinics scattered all over the country. Since the Catholic Church forbids the use of barrier methods of contraception, how does it wrestle with unwanted pregnancies and related responsibility in sexually

transmitted disease awareness promotion? The global summary of the AIDS epidemic informs us that 4.3 million people were infected with HIV in 2006 where 530 000 were children under 15 years of age. In Africa and Latin America, strict obedience to the Church's teachings remains strong, so it is reasonable to assume that by failing to use condoms hundreds of thousands of new cases of HIV/AIDS infections each year are officially sanctioned by the Church's contraception policy. In 2003 there were an alarming 29.4 million HIV/AIDS sufferers living in sub-Saharan Africa, with the total figure predicted to double by 2010. No wonder that limited use of condoms (as the 'lesser' evil in the fight against AIDS) is allowed by some more liberal African and Latin American clergy. Nevertheless, the need for sexual education is urgent as HIV/AIDS and other sexually transmitted infections spread, and children are brought into a world without a just future. Making condoms more accessible, lowering their cost, promoting them more, and helping to overcome social and personal obstacles to their use would save many lives and reduce the enormous consequences and costs of sexually transmitted disease and unwanted, at-risk pregnancies.

Principles of bioscience ethics for discussion

- Myth no. 1: that people with influence, in their present state of biological ignorance, are qualified to enunciate which methods of contraception are natural and which are not.
- Myth no. 2: it is only a woman's age that matters; men can have healthy children well into their old age.
- Not a myth: the United Nations statistics for 2006 revealed that a total of 39.5 million adults and children were living with the human immunodeficiency virus (HIV) and a total of 2.9 million adults and children died of AIDS that year. Ninety per cent of new infections occur in the developing countries where ready access to condoms may be restricted and post-infection treatment is minimal or non-existent.
- Can institutionalized denial of responsible control over one's own reproductive and sexual health justify the addition of serious health risks borne by the next generation of children? How may we best annul long-held belief systems which are biologically impertinent and inhumane?