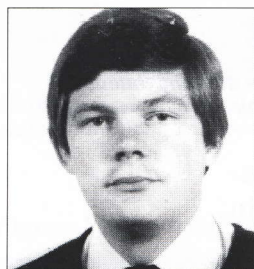


Fertility mastery – an update on cervical mucus



Curriculum Vitae

Heinz qualified at Wits, firstly with a BSc (Med) in 1980 and then a MBChB in 1983. He is working in Paediatric Surgery at Baragwanath Hospital, and is presently a national executive of the Fertility Mastery Association of SA (FERMASA). Heinz has met and worked with international researchers and scientists involved in developing and promoting the effective modern methods of natural family planning (NFP), viz the Billings Ovulation and Symptothermal Method.

Summary

A short article, reviewing today's knowledge of the cervical mucus and its correlation to the woman's symptoms of fertility. It has been concluded that by following the natural fertility symptoms and signs inherent in the woman's body, the efficacy rates of the modern natural family planning methods are similar to that of the contraceptive pill.

The endocervical canal contains over 400 crypts which secrete mucus (Figure 1). It has been known for some time that different types of mucus are produced at different times of the cycle^{5, 17, 18} but more details have only recently been elucidated by Odeblad and co-workers.¹¹⁻¹⁶

The clinical perception of cervical mucus secretion at the vulva precedes ovulation and is dependent on the growth of a maturing follicle in the ovary. It is for this reason that the fertile and infertile time in each menstrual cycle can accurately be assessed by women.

This is a review of today's knowledge of the cervical mucus and its correlation to the woman's symptoms of fertility.

Clinically the cervi-

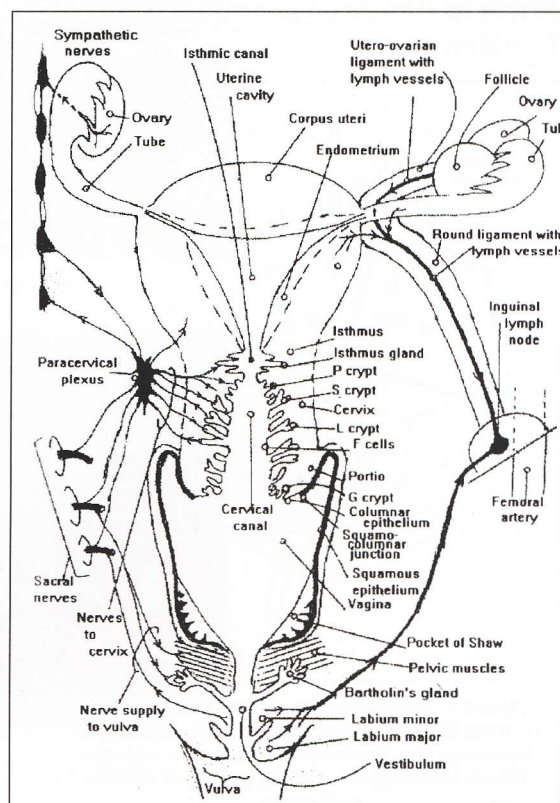
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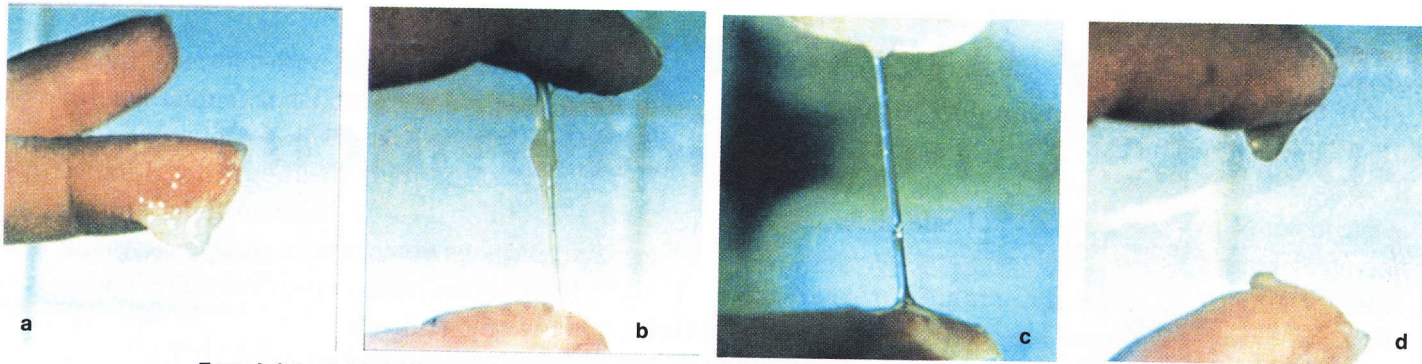
KEYWORDS

Family planning;
Cervix mucus;
Fertility.

Figure 1: The cervical canal and important structures of the female genital system. The nerve supply is indicated on the left and the lymphatic drainage on the right.



An update on cervical mucus



From left to right: (a) Pre-ovulatory mucus will not stretch and breaks. (b) Fertile-type stretchy mucus. (c) Clear fertile-type mucus close to the Peak. (d) Mucus after the peak

cal mucus (Figure 2) has been described by its:

1. colour – yellow, opaque, clear or transparent; and
2. texture – tacky, slippery, wet, lubricative, stretchy.

This clinical description refers to the:

1. combination of the different types and quantity of the mucus produced by the different crypts of the cervix;
2. contributions from the isthmus, endometrium and tubes;
3. peritoneal and follicular fluid; and
4. mucus modification during its passage through the vagina.

Mucus has three components (Figure 3):

1. water;

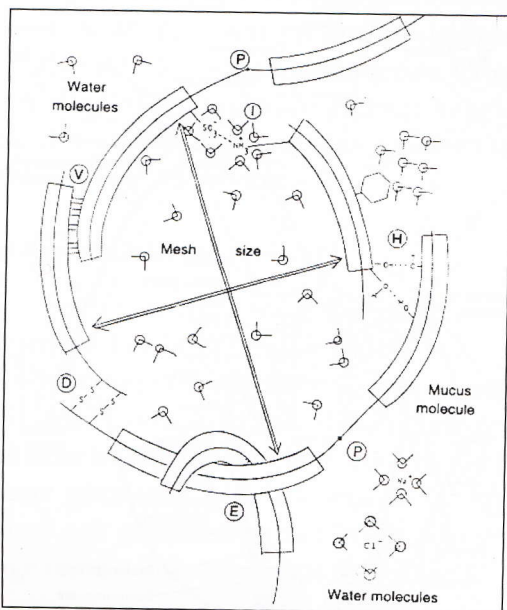


Figure 3: The molecular structure of mucus. I – ionic bond; P – peptide bond; H – hydrogen bonding; D – disulphide linkage; V – van der Waals bonding; E – entanglement of mucus molecules.

2. chemical and biochemical compounds – sodium chloride, protein chains and enzymes; and
3. mucus molecules which are glycoproteins with a molecular weight of 70 000 daltons. Mucus molecules are able to join together to form polymers or extended three dimensional networks producing gels.

The cervix contains three cell types:

1. reserve cells;
2. cylindrical columnar ciliated cells; and
3. cylindrical columnar secretory cells which make up the vast majority of the cervical cells. These cells have a variety of different hormonal and nerve receptors which are responsible for their mucus production. The mucus secretion resulting from hormonal receptor stimulation is slow when compared to the rapid response resulting from the noradrenalin β receptor stimulation.

Cervical mucus

When cervical mucus is spread onto a glass slide and allowed to quick air dry, various ferning and crystal patterns are discernible when visualised under low magnification. Using this technique a conglomerate pattern of different types of mucus is obtained (Figure 4).

Using refined techniques pure mucus samples from individual cervical crypts can be obtained. To date Odeblad has described four types of cervical mucus (Figure 5), each

Pregnancy revives the chronological age of the cervix.

An update on cervical mucus



Figure 4: Air dried cervical mucus showing an admixture of S-mucus and L-mucus.

described by their unique crystallising pattern, and each produced by unique and independent cervical crypts.

The cervical mucus types are:

- G mucus (gestagen)
- L mucus (locking-in)
- S mucus (sperm conducting)
- P mucus (peak)

More recently an F mucus (fundamental) has been described.

Figure 5: Air-dried cervical crypt mucus ferming/crystallising pattern

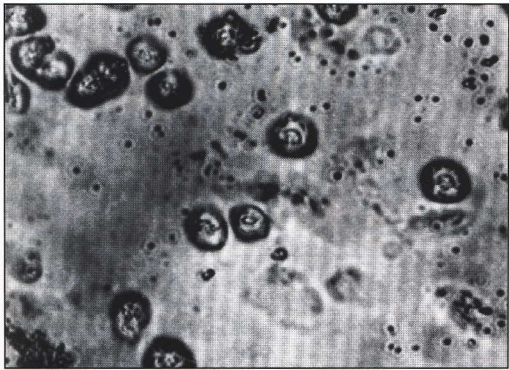


Figure 5a: G- mucus (Magnification 1 000x)

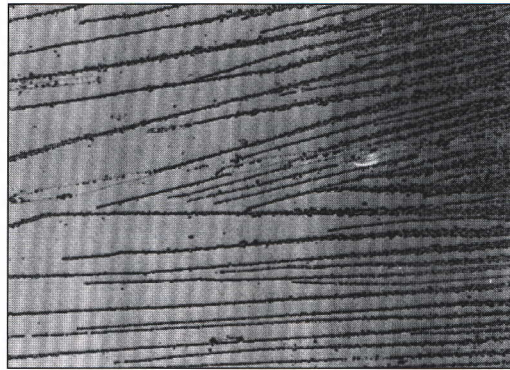


Figure 5d: S mucus Magnification 200x)

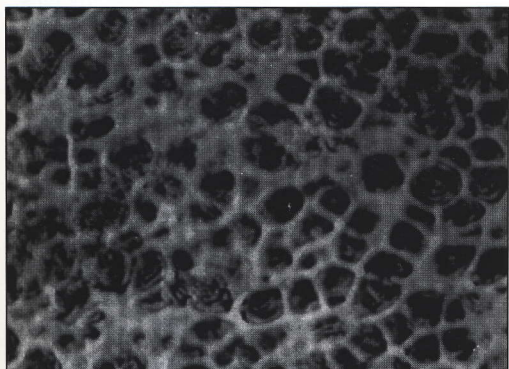


Figure 5b: G+ mucus Magnification 1 000x)



Figure 5e: P mucus (Magnification 400x)



Figure : L-mucus (Magnification 100x)

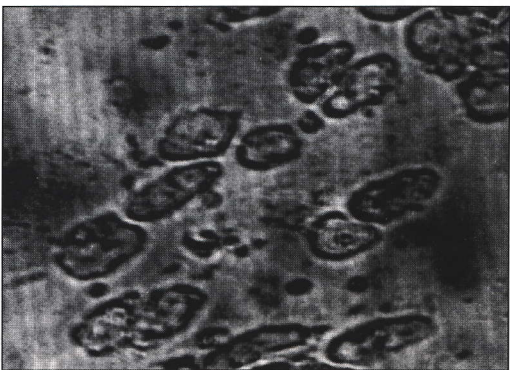


Figure 5f: F mucus Magnification 1 000x)

A woman taking the pill for five years has a cervix looking five years older than her chronological age.

An update on cervical mucus

I. The G mucus

The G mucus was first identified in 1968. It has no particular crystallisation pattern and is produced under the influence of progesterone (gestagen). It contains epithelial cells (50%), leucocytes (25%) and lymphocytes (25%) – the latter two being influenced by the presence of interleukins. It is responsible for the mucus plug at the external os of the cervix and it is therefore not surprising that the ± 60 G mucus crypts are situated at the lower end of the cervical canal (Figure 6). The G mucus produces no sensation in the female genital tract. The vulva feels dry and the woman is infertile during this period.

In the pre-ovulatory (the first infertile phase of the cycle) progesterone levels are low (Figure 7) but sufficient to

stimulate the G cervical crypts to produce a feeble (G-) mucus. After ovulation progesterone levels are high and the G crypts produce a very dense G+ mucus which again plugs the external os of the cervix.

The G mucus is impenetrable by sperm.¹¹ Furthermore micro-organisms have difficulty in advancing through this mucus and together with the leucocytes, lymphocytes and immunoglobulins the G mucus provides an excellent defence against ascending infection. Women using the IUD have strings which disrupts the

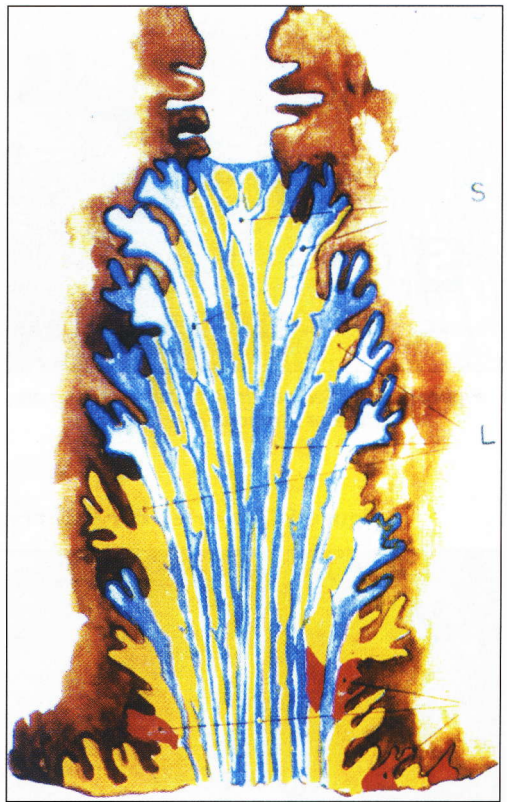
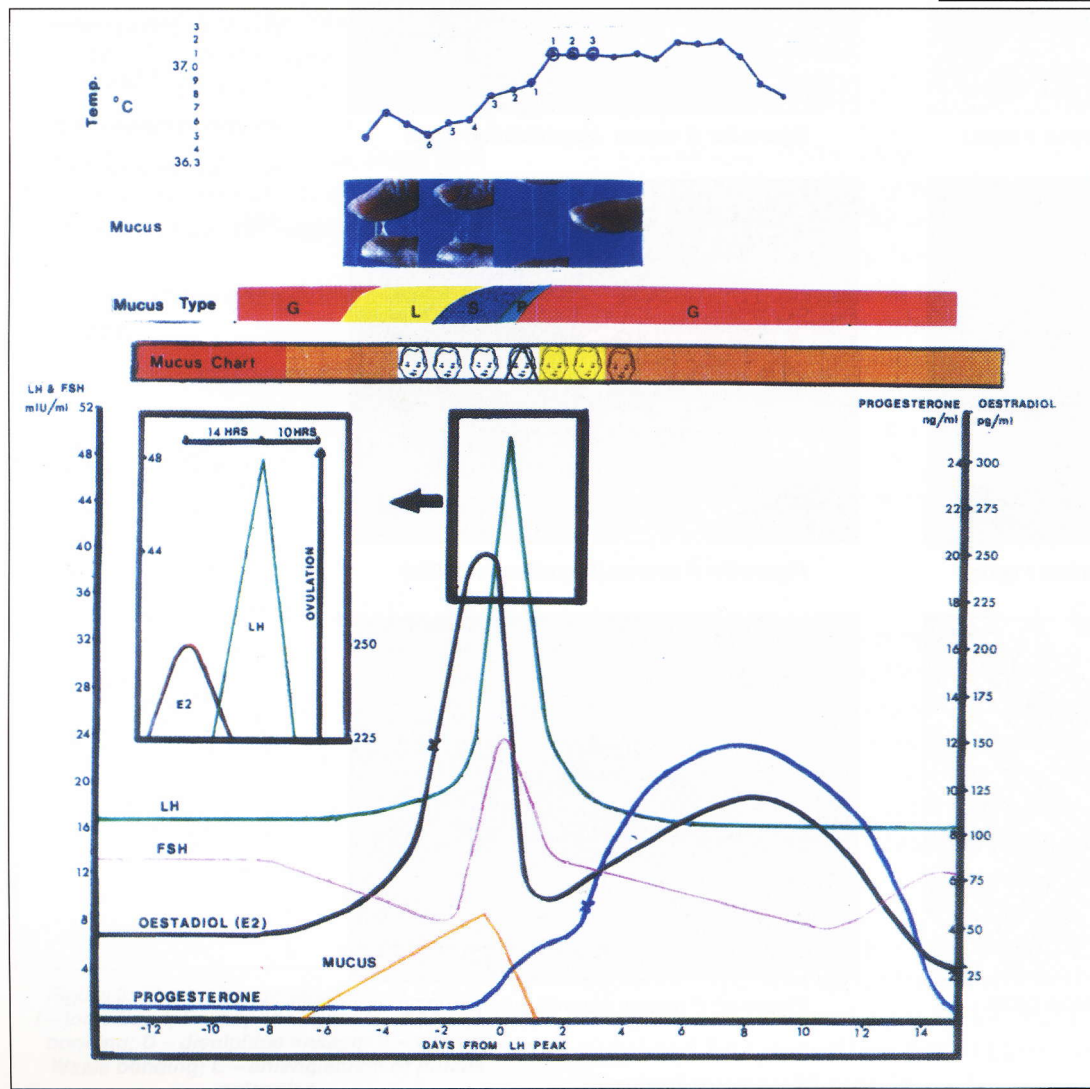


Figure 6: A simplified diagram indicating the distribution of the L-mucus units (loafs) of the S-mucus units (strings) and of the G-mucus in the cervical canal at the time of ovulation.



Modern natural family planning has become highly effective.

Left: Figure 7: Correlation of the woman's observations, charting, mucus type and serum hormonal levels.

natural G mucus barrier.

2. The L Mucus

The L mucus was first described in 1978 and has a very characteristic arborisation (ferning) pattern with 90° branching when allowed to dry on a glass slide (Figure 5 on the page 594). The ± 200 L mucus crypts are situated in the middle of the cervical canal above the G mucus crypts and interspersed with the S mucus crypts (Figure 6). The L mucus is secreted in response to medium and rising oestrogen levels (Figure 7). It is produced in larger quantities than the G mucus and leaves the cervix and the vagina to be perceived as a wet, tacky substance at the vulva. The L mucus provides a structural scaffolding for the more fluid S mucus and also assists in the trapping of non-streamlined abnormal sperm, ie, it has a locking-in effect (hence the name L mucus) of the 4-20% abnormal sperm that normally occurs in semen.¹²

3. The S mucus

This mucus type was first described in 1977. It crystallises out into a linear needle shaped crystal on air drying (Figure 5). It is a very fluid substance which flows continuously from the S crypts flowing between the 'pearls' of the L mucus and produces the wet, slippery sensation at the vulva. In the S mucus the molecules aggregate to form long threads called micelles, creating channels which direct the high quality sperm upwards into the ± 100 S crypts in three to 10 minutes.¹⁵ Here the sperm are revitalised and capacitation takes place. S mucus is essential if fertility is to be achieved. The S mucus is also responsible for alkalinity in the vaginal acidic environment, thereby prolonging the fertilising capacity of sperm from a few minutes to approximately five days. The S mucus is produced in response to high oestrogen levels (Figure 7). Shortly before ovulation, the oestrogen

level drops. The increased noradrenalin level, which parallels the LH levels, maintains the S mucus flow until ovulation. The increased noradrenalin level explains another finding women have reported, viz, the increased pulse rate around the time of ovulation. The immediate response of noradrenalin on secreting S mucus crypts is responsible for the sudden discharge that some women experience in acute stress at the time of ovulation.

4. The P mucus

This mucus type was first described as

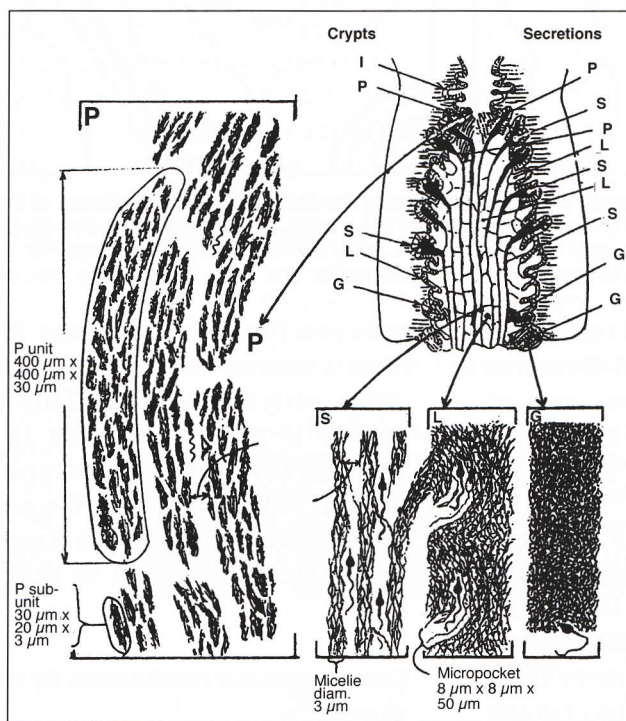


Figure 8: Distribution and macromolecular composition of cervical mucus types S, L, G and P.

recently as 1991 and is characterised by the 60° branching (hexagonal) ferning pattern produced on air drying (Figure 5).

The P mucus production is stimulated by a fall in oestrogen and the presence of noradrenalin.

The ± 40 P mucus crypts are situated in the uppermost part of the cervix known as the dome. The mucus it produces is more viscid than the S mucus and the molecules aggregate to form 'discs' arranged in an onion-peel fashion

Efficacy of modern natural methods are similar to that of the contraceptive pill.

Over 50-million couples worldwide are using the ovulation method of natural family planning.

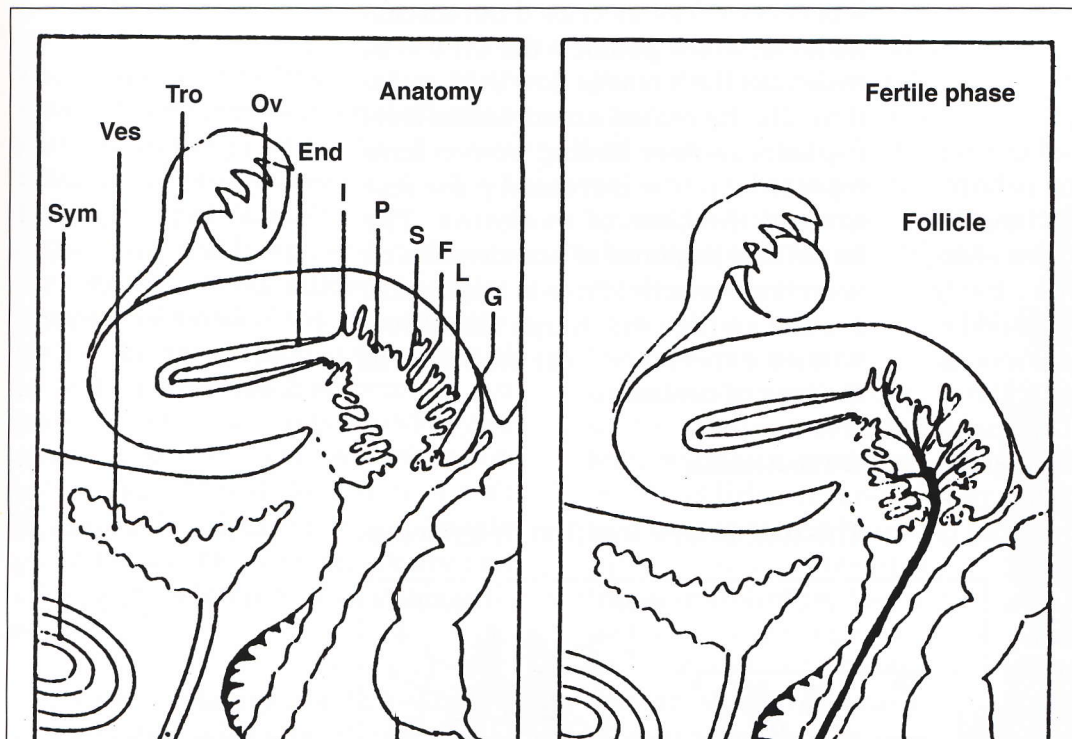


Figure 9: Cervical anatomy and mucus and fluid flow during the fertile and infertile phases of the cycle. The locations of crypts P, S, L and G are indicated as are the F cells, I – isthmus (secretion Z); Can cerv, cervical canal; End, endometrium. L. maj, labium majora; L. min, labium minora; Ov, ovary; Per, perineum; Pc Shaw, Pockets of Shaw; Rec, rectum; Sym, symphysis pubis; Tro, tube; Vag, vagina; Ves, bladder.

(Figure 8). It contains weak mucolytic enzymes which liquifies and dissolves the L and S mucus. The P mucus then channels the sperm from the crypts into the uterine cavity.

The mucolytic effect of the P mucus affects the flow of mucus leaving the vagina. Since the mucus is broken down into smaller pieces its surface area is increased thereby increasing the vulval sensation of slipperiness. The P mucus is maximal on the Peak day of the ovulation method of natural family planning.

The mucolytic activity is the result of enzymes which are associated with granular spheres (1µm), secreted by glands in the isthmus, which adheres to the P mucus. Odeblad has called this granular secretion the Z secretion and it has the capacity to form annular or stellate shapes when air dried.

5. The F mucus

The F mucus is produced in the epithelium covering the endocervical wall

between the crypt openings. It resembles G mucus but contains no leucocytes or lymphocytes. This type of mucus is more abundant in young women. It is this mucus type that is present in the basic infertile pattern of the ovulation method. No function has as yet been ascribed to this mucus type.

Cervical mucus modulation by the vagina

The vagina has a modulating effect on the cervical mucus during its passage from the cervix to the vulva (Figure 9). During the pre-ovulatory infertile period the vaginal lining is thin and secretes manganese. This results in the absorption of fluid from any mucus in the lower vaginal recesses known as the pockets of Shaw. The vulval sensation is therefore one of dryness. With the onset of oestrogen release from the maturing follicle the vaginal epithelium thickens and manganese is no longer released from the vaginal mucosa. As a result, fluid is no longer absorbed from the cervical mucus (L and S mucus)

An update on cervical mucus

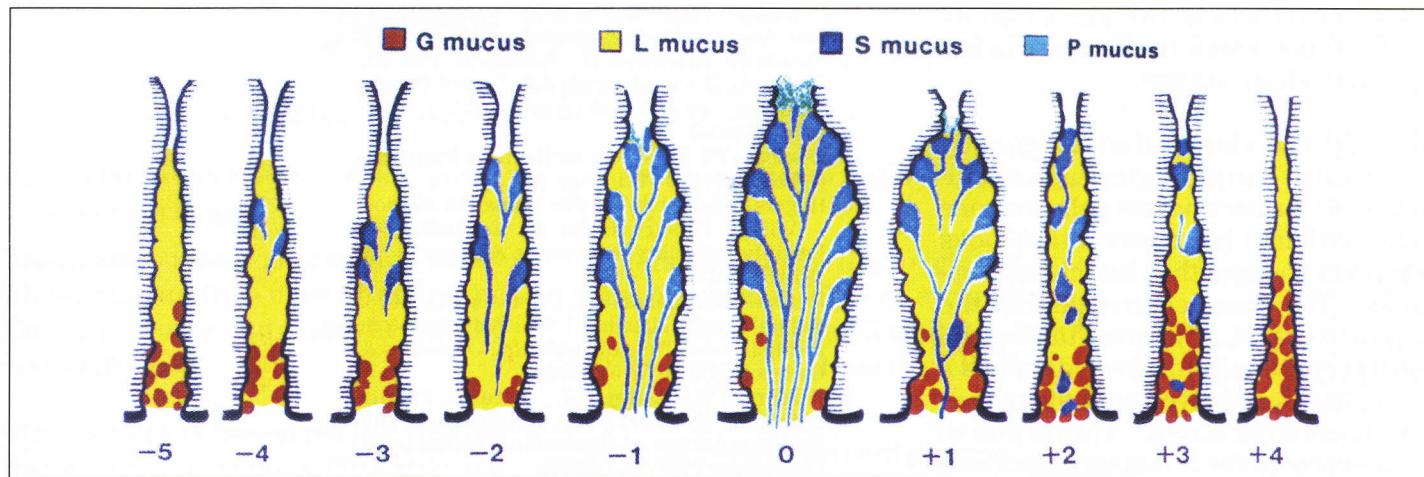


Figure 10: Distribution of mucus types inside the cervical canal around the Peak day (day 0) in an individual cycle.

resulting in a wet lubricative sensation at the vulva.

In addition, the sensitivity of the vulva is increased by the unilateral vulval oedema that occurs at this time. This is the result of lymphatic obstruction that usually occurs on the side of the ovary containing the dominant follicle.^{13, 16}

The cervix a biological valve

The cervix is progressively stimulated from the lowest lying G mucus crypts upwards (Figure 10). First the L crypts by the rising oestrogen followed by the S mucus crypts in response to the higher oestrogen levels and noradrenalin

and finally the uppermost P mucus crypts at the peak day. The post ovulatory progesterone rise again closes the cervical canal while the P mucolytic mucus continues to release and channel sperm from the S crypts into the uterine cavity.

The cervix and age

With age the cervical mucosa retracts progressively within the cervical canal and the number of S mucus crypts decrease either due to atrophy or replacement by L or G crypts so that only the highest part of the cervix contains S mucus crypts (Figure 11). The number of slippery and lubricative mucus days decreases from seven to eight days at the time of puberty to only

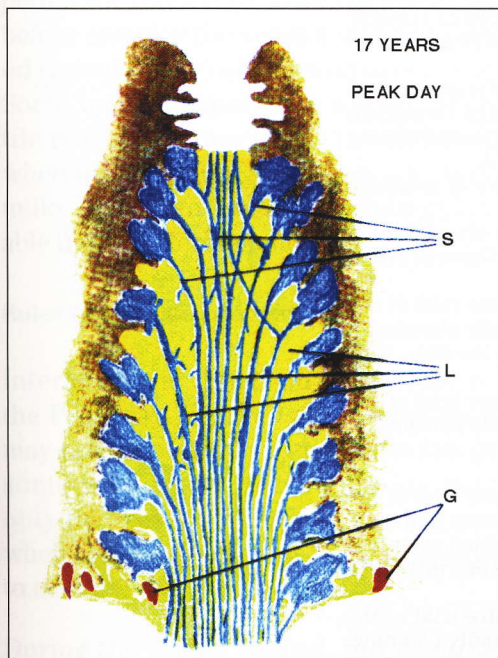


Figure 11a

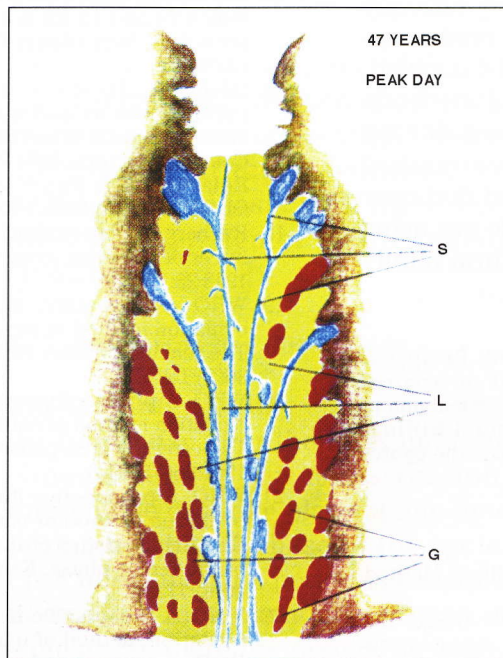


Figure 11b

Figure 11a: Representation of total activity of the cervix in a 17-year-old girl on her peak day: the active S-mucus producing parts distributed over the whole cervix.

Figure 11b: The cervical canal of a 47-year-old woman. Note how only the highest part of the cervical canal contains S-mucus active crypts.

one or two days at the age of 35-37 years.¹³ This explains the decrease in fertility with advancing age.

Odeblad has shown that pregnancy revives the chronological age of the cervix. A woman who has delivered one to two children has a cervix that looks five years younger than her chronological age. The contraceptive pill has the opposite effect. A woman taking the contraceptive pill for five years has a cervix that looks five years older than her chronological age.¹³ This is due to the atrophy of the S mucus crypts as a result of the low oestrogen level maintenance by the low dose contraceptive pill which is insufficient to stimulate the S mucus crypts.

Recent scientific studies of hormonal profiles,^{4,6-10} the ultrasonographic following of ovarian follicular development to maturity and ovulation and Odeblad's research of cervical mucus have verified and explained why the Billings Ovulation and Symptothermal Methods of natural family planning are highly effective.^{1,3} Natural family planning (NFP) affords fertility mastery to both first and third world population groups as shown by the World Health Organisation^{19,22} and the experience here in rural and urban South Africa. NFP can be used either to achieve or to postpone pregnancy as desired by the couple. By following the natural fertility symptoms and signs inherent in the woman's body efficacy rates approaching that of the contraceptive pill, if a pregnancy is to be avoided, can be attained. The natural methods can also be effectively used during breast feeding and peri-menopausal women. It has been estimated that over 50-million couples worldwide are using the ovulation method of natural family planning.

Acknowledgements

I wish to acknowledge and thank Professor Odeblad most kindly for his gift of original microphotographs of the different cervical mucus types and together with Professor J Billings (WOOMB) for permission to reproduce the figures used in this article.

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APPENDIX I

Natural family planning methods

A. The Ovulation Method of natural family planning

The ovulation method of natural family planning was first described by the Billings' couple and published in the *Lancet* in 1972.¹

The method is based on the finding that women can identify the fertile and infertile times of the menstrual cycle by physically observing the wet and lubricative sensation the cervical mucus produces at the vulva.

The fertile time commences with a feeling of wetness and the appearance of an opaque, pasty type of mucus at the vulva which is non-elastic and breaks when stretched. The mucus changes to become clearer and stringy and finally appears like the raw white of an egg – transparent, clear and stretchy and the sensation of wetness becomes more marked. The last day of clear raw egg white-type mucus is called the Peak day. Following the Peak day the mucus reverts back to a sticky, cloudy nature or no mucus at all – a feeling of vulval dryness. The couple remains in the fertile period for three days after the Peak day before entering the second infertile period (luteal phase) of the woman's cycle. Some women experience a basic infertile pattern of mucus all the time (eg when breast feeding) – this is a watery, milky discharge and easily distinguishable from the fertile mucus.

Rules to achieve pregnancy

Intercourse is timed on days close to the Peak day. Fertile-type mucus days may not be present in all cycles and in some women the fertile mucus may only be present for part of a day but when present, sufficient for conception to occur.

During the fertile period, intercourse can result in a pregnancy in up to 75%

of couples with normal fertility during the first cycle.²

Hilgers has shown that ovulation will have occurred in 98,4% of cycles during the seven days Peak-3 to Peak+3 and 70,7% during the three days Peak-1 to Peak+1.²

Rules for the avoidance of pregnancy

1. Menstrual bleeding

The first day of menstruation is day one of the cycle. Couples should defer intercourse during this time since during a short cycle cervical mucus flow may have begun before the menstrual flow has stopped.

2. Early infertile day (pre-ovulatory) rule

Intercourse (I) is confined to the evenings of alternate dry days (see chart on page 601) – this ensures that seminal fluid and vaginal secretions do not obscure cervical mucus appearing the day following intercourse. The early infertile days can vary in duration from cycle to cycle.

3. Fertile days – Peak rule

Sexual contact is postponed from the loving relationship as soon as the cervical mucus appears at the vulva producing the sensation of wetness and lubrication and lasts until three days after the last sign of fertile mucus (Peak day).

4. Late infertile day (luteal) rule

The late infertile day commences on the fourth day after the Peak until the commencement of menstruation. Intercourse can take place at any time during this luteal phase of the cycle. (The luteal infertile period is constant in duration for a particular woman. A woman can therefore predict the onset of her menstruation very accurately.

An update on cervical mucus

Women with a short luteal phase have suboptimal luteal function and may require luteal support to overcome recurrent miscarriages. Prolonged luteal phases (>16 days) may be indicative of the luteinized unruptured follicle syndrome.)

5. Stress situations

Stress situations such as acute anxiety, travel, change of environment, strenuous exercise and so forth, may delay or abolish ovulation which will become evident by the altered cervical mucus pattern of the woman. Following the above rules the woman can determine her fertility.

When the guidelines for the avoidance of pregnancy are followed as listed above, a method success rate of over 98% is attained.²

The ovulation method is best taught to couples by trained NFP teachers who will help elucidate fertile and infertile phases of the woman's cycle, how to observe, chart and interpret the woman's signs of fertility and how to distinguish arousal fluid and pathological vaginal discharges from the fertile cervical mucus. Women who are breastfeeding and women entering the menopause can also be taught how to use the ovulation method successfully. Follow up by NFP teachers helps user

couples achieve the method success rate as stated above.

B. The symptothermal method of natural family planning

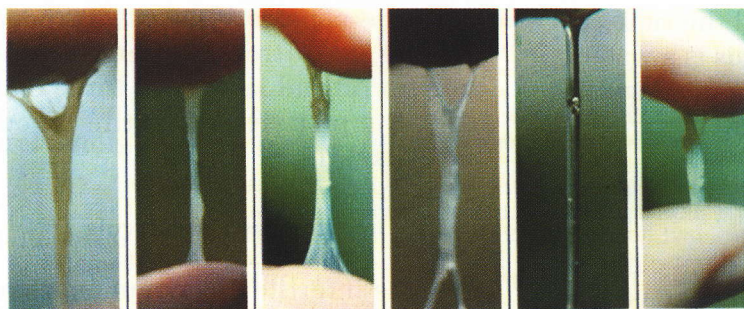
The symptothermal method combines the observation of cervical mucus, as for the Billings Method, and the changes in body temperature in a cross checking way to determine the fertile and infertile phases of the cycle. The basal body temperature rises by 0,2°C as a result of ovulation and the production of progesterone by the corpus luteum.

NFP is not merely a method of family planning but a way of life. Both the husband and the wife respect the natural cycle of fertility and infertility and together make decisions. This raises the dignity of women and the need for men to be involved – a couple method.

For further details and names of NFP teachers contact The Fertility Mastery Office at PO Box 941, Pretoria 0001 or Tel: (012) 323-6458.

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Peak day

