Physiology of Reproduction III

Menstrual Cycle, Gamete transport, Gamete interaction and Fertilization

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• Menstrual Cycle

• Sperm transport in female reproductive tract

• Sperm maturation in female genital tract (Capacitation)

• Gamete interaction

• Fertilization
Menstrual Cycle
Days 26 - 28
The uterine lining detaches leading to menstruation

Days 18 - 25
If fertilisation has not taken place the corpus luteum fades away

Days 1 - 7
Menstruation (3 - 7 days)

Days 8 - 11
The lining of the womb thickens in preparation for the egg

Day 14
Ovulation
Sperm transport in female reproductive tract

- A small number of spermatozoa reach to the upper part of female reproductive tract
- Both sperm motility and female reproductive tract movement are responsible for sperm transport
- Cervical mucus Penetration test
Ovary

Uterus
## How Common is Sperm Storage?

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Duration stored</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insects</strong></td>
<td></td>
</tr>
<tr>
<td>Grasshopper</td>
<td>26-113 days</td>
</tr>
<tr>
<td>Water strider</td>
<td>30 days</td>
</tr>
<tr>
<td>Stick insect</td>
<td>77 days</td>
</tr>
<tr>
<td><em>Dorsophila</em></td>
<td>14 days</td>
</tr>
<tr>
<td><strong>Reptiles</strong></td>
<td></td>
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<tr>
<td>Turtles-tortoises</td>
<td>90-1460 days (4 years)</td>
</tr>
<tr>
<td>Snakes</td>
<td>90-2555 days (7 years)</td>
</tr>
<tr>
<td>Lizards</td>
<td>30-365 days (1 year)</td>
</tr>
<tr>
<td>Crocodiles</td>
<td>7 days</td>
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<tr>
<td><strong>Birds</strong></td>
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<tr>
<td>Chicken</td>
<td>21-30 days</td>
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<tr>
<td>Turkey</td>
<td>56-117 days</td>
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<tr>
<td>Finch</td>
<td>8-16 days</td>
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<tr>
<td>Canary</td>
<td>68 days</td>
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<tr>
<td><strong>Mammals</strong></td>
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<tr>
<td>Marsupials</td>
<td>0.5-16 days</td>
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<tr>
<td>Bats</td>
<td>16 days-6 months</td>
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<tr>
<td>Mouse</td>
<td>0.6 days</td>
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<tr>
<td>Human</td>
<td>5 days</td>
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<tr>
<td><strong>Fish</strong></td>
<td></td>
</tr>
<tr>
<td>Shark</td>
<td>Up to several years</td>
</tr>
</tbody>
</table>

*Birkhead et al. 1998*
Virtual Experiment

Investigating Reflection
Virtual Experiment Parameters

- 1500 sperm
- Initial start in the isthmus and point towards the ampullar region
- All active
- All progressive
- No attachment to epithelium
- No internal environmental factors, such as fluid movement
- Demonstrate influence of a single factor
Reflection (Natural)

$\alpha = \text{Incident Angle}$

$\alpha = \text{Reflection Angle}$
Reflection (Random 180)

\[ \alpha = \text{Incident Angle} \]
\[ [0 - 180] = \text{Reflection Angle} \]
Reflection (Random Cone)

$\alpha = \text{Incident Angle}$
$\delta = \text{Reflection Angle (60, 30)}$
Natural Reflection

180° Random Reflection

30° Cone Reflection

60° Cone Reflection
• Capacitation was first discovered by Chang and Austin independently (1950).

• The final maturational stage of spermatozoa that takes place in the female genital tract, before spermatozoa gain the ability to fertilize oocyte.

• It is one of the most investigated areas of andrology and one of the least understood areas of andrology.
(c) Cleavage furrow
Released cortical granule

(d) Polar body 1
Female pronucleus
Male pronucleus
Sperm tail and centriole
Polar body 2
Early Stages of Fertilization in vitro of Human Oocytes Matured in vitro

by

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Human oocytes have been matured and fertilized by spermatozoa in vitro. There may be certain clinical and scientific uses for human eggs fertilized by this procedure.

The technique of maturing human oocytes in vitro after their removal from follicles provides many eggs for studies on fertilization. Their fertilization in vitro would yield a supply of embryos for research or clinical use, but in previous attempts the incidence of fertilization was too low to be useful.

A possible solution to the problem of obtaining “capacitated” spermatozoa has recently emerged from experiments on hamster eggs, where the addition of epididymal spermatozoa to eggs in tubal or follicular secretions can lead to a high incidence of fertilization. Study of the conditions leading to capacitation of hamster spermatozoa and fertilization in vitro has led to the use of a medium based on Tyrode’s solution, but with extra bicarbonate (final concentration 3 mg/ml); also added were sodium pyruvate (9.0 µg/ml), bovine serum albumin (2.5 mg/ml),
Letters to the Editor

BIRTH AFTER THE REIMPLANTATION OF A HUMAN EMBRYO

Sir,—We wish to report that one of our patients, a 30-yearold nulliparous married woman, was safely delivered by caesarean section on July 25, 1978, of a normal healthy infant girl weighing 2700 g. The patient had been referred to one of us (P.C.S.) in 1976 with a history of 9 years' infertility, tubal occlusions, and unsuccessful salpingostomies done in 1970 with excision of the ampulla of both oviducts followed by persistent tubal blockages. Laparoscopy in February, 1977, revealed grossly distorted tubal remnants with occlusion and peritubal and ovarian adhesions. Laparotomy in August, 1977, was done with excision of the remains of both tubes, adhesolysis, and suspension of the ovaries in good position for oocyte recovery.

Pregnancy was established after laparoscopic recovery of an oocyte on Nov. 10, 1977, in-vitro fertilisation and normal cleavage in culture media, and the reimplantation of the 8-cell embryo into the uterus 2½ days later. Amniocentesis at 16 weeks' pregnancy revealed normal α-fetoprotein levels, with no chromosome abnormalities in a 46 XX fetus. On the day of delivery the mother was 38 weeks and 5 days by dates from her last menstrual period, and she had pre-eclamptic toxemia. Blood-pressure was fluctuating around 140/95, oedema involved both legs up to knee level together with the abdomen, back, hands, and face; the blood-urea-acid was 390 μmol/l, and albumin 0.5 g/l of urine. Ultrasonic scanning and radiographic appearances showed that the fetus had grown slowly for several weeks from week 30. Blood-estriols and human placental lactogen levels also dropped below the normal levels during this period. However, the fetus grew considerably during the last 10 days before delivery while placental function improved greatly. On the day of delivery the biparietal diameter had reached 9.6 cm, and 5 ml of amniotic fluid was removed safely under sonic control. The lecithin: sphingomyelin ratio was 3-9:1, indicative of maturity and a low risk of the respiratory-distress syndrome.

We hope to publish further medical and scientific details in your columns at a later date.

P. C. STEPTOE

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And here she is...
THE LOVELY LOUISE
• Artificial Insemination (AI)
• Embryo Transfer (ET)
• In Vitro Fertilization (IVF)
• Intra-Cytoplasmic Sperm Injection (ICSI)
• Somatic Nuclear Transfer (Cloning)
• Stem Cell Therapy (Regenerative Medicine)
• IPS Cells (Induced pluripotent Stem Cells)
• ???
• Are we creating an infertile population by assisted conception?

  – Many couples that a decade ago had no chance of becoming parents, now can conceive and have their own babies.

  – Many causes of infertility (particularly male infertility) are heritable.

  – In theory the more we use assisted conception the more would be the number of patients in need of fertility treatment.
• How many generation would it take till all fertile couples disappear on the plant and all the world population would be in need of assisted conception?
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