"Fertilization"

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1. Introduction

- Fertilization = fusion of male (sperm) and female (oocyte) gametes
- Results in formation of a zygote (diploid, 2n)

Site

- Occurs in ampullary region of the uterine (fallopian) tube

Transport of Gametes

- Sperm travel:
    - From cervix → uterus → uterine tube

- Time: 30 minutes to 6 days

Key Concept

- Sperm movement is mainly due to:
  - Uterine + tubal muscular contractions
  - Not primarily by sperm motility

Clinical Correlation

- Implantation outside uterus → ectopic pregnancy (commonly in tube)

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2. Requirements for Fertilization

A. Capacitation

Definition

- Functional maturation of sperm in female reproductive tract

Key Features

Feature	Description
Site	Female genital tract
Time	~7 hours
Changes	Removal of glycoprotein coat + seminal proteins
Cause	Interaction with uterine epithelium

Result of Capacitation

Capacitated sperm → Can penetrate corona radiata → Can undergo acrosome reaction

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B. Acrosome Reaction

Definition

- Release of enzymes from acrosome

Enzymes Released

- Acrosin
- Trypsin-like enzymes

Function

- Digest zona pellucida → Allow sperm penetration

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3. Structure Around Oocyte

Structure	Description
Corona radiata	Layer of cumulus (granulosa) cells around oocyte
Zona pellucida	Glycoprotein shell surrounding oocyte

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4. Steps of Fertilization

Step 1: Penetration of Corona Radiata

- 200–300 million sperm deposited
- Only 300–500 reach ampulla
- Only one fertilizes the oocyte

Mechanism

Capacitated sperm → Pass through corona radiata →

Assisted by enzymatic + mechanical action

Step 2: Penetration of Zona Pellucida

Key Factor

- ZP3 receptor (zona protein)

Mechanism

Sperm binds to ZP3 → Triggers acrosome reaction →

Release of enzymes → Zona pellucida penetrated

Step 3: Fusion of Cell Membranes

Sperm membrane + Oocyte membrane → Fusion occurs

→ Sperm nucleus enters oocyte

5. Changes After Fertilization

A. Cortical & Zona Reaction (Block to Polyspermy)

Mechanism

Oocyte activation → Cortical granules released → Zona pellucida modified → Becomes impermeable to other sperm

High-Yield Concept

- Prevents polyspermy (multiple sperm entry)

B. Completion of Meiosis II

Secondary oocyte (Metaphase II arrest) → Resumes meiosis II → Forms:

- Ovum
- Second polar body

C. Metabolic Activation

- Initiates embryogenesis
- Activates:
    - Protein synthesis
    - DNA replication

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6. Formation of Pronuclei

Process

Male pronucleus (n) + Female pronucleus (n) → DNA replication → Fusion (syngamy) → Zygote (2n)

Flowchart

Sperm entry → Oocyte completes Meiosis II → Male + female pronuclei form → DNA replication → Fusion → Zygote formation → First mitotic division → 2-cell stage

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7. Results of Fertilization

Result	Explanation
Restoration of diploidy (2n)	Combines maternal + paternal chromosomes
Sex determination	XX (female) or XY (male)

Initiation of cleavage	Start of embryonic divisions

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8. Fate of Oocyte if Not Fertilized

- Oocyte degenerates within ~24 hours after ovulation

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9. Integrated Overview

Sperm deposited → Capacitation (7 hours) → Acrosome reaction → Penetration of corona radiata → Binding to ZP3 → Penetration of zona pellucida → Fusion of membranes → Sperm enters oocyte → Cortical reaction (block polyspermy) → Meiosis II completes → Male + female pronuclei → Fusion → Zygote (2n) → Cleavage begins

10. Clinical Concepts

a. Polyspermy

- Failure of cortical reaction → Multiple sperm entry
  → Nonviable embryo

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b. Ectopic Pregnancy

- Fertilization occurs normally
- Implantation occurs outside uterus
  → Most common site: ampulla

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c. Infertility Causes

- Failure of:

- Capacitation
- Acrosome reaction
- Tubal transport

II. Exam Points

- Site: Ampulla of uterine tube
- Capacitation required before fertilization
- ZP3 → triggers acrosome reaction
- Only one sperm fertilizes
- Cortical reaction prevents polyspermy
- Secondary oocyte completes meiosis II after fertilization
- Pronuclei fusion → zygote
- Sex determined at fertilization

-> The End <-