Untangling Reproductive Success: 
*Caenorhabditis* Nematodes as a Model System for Fertilization 
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Reproductive Health is a World-Wide Goal

- **World-Wide Female Infertility**
  - [Graph showing World-Wide Female Infertility]

- **Reproductive health includes the “capability to reproduce...**
  - and the freedom to decide if, when, and how often.” (WHO)
  - In US, 90% of infertility examinations are initiated in female partners alone, while males account for ~23% of all infertilities.
  - Impaired fecundity and infertility are characterized by abnormal sperm and poor semen quality.
  - These same sperm traits are related to male-specific health issues, such as testis and prostate cancers.
  - CDC now considers infertility a disease.

Understanding the molecular basis of infertility is important for diagnosing and treating not only infertility, but also male-specific health issues.

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*Caenorhabditis* Nematodes as a Model System

- **Free-living life history with a preference for rotting fruit and vegetation**
- **Natural variation in the strength of sexual selection**
- **Three independent lineage transitions to self-fertilizing hermaphrodites**
- **One lineage transition to sperm gigantism**
- **High quality genome assemblies available for most of the Elegans supergroup**

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What Comprises the Male Reproductive Proteome?

**Goal:** To characterize the complete set of sperm proteins (sperm proteome) in *C. elegans* and *C. remanei* and analyze the molecular evolution.

**Sperm Collection: Shredder v5.0**

- Microfluidic technique that allows for worms to be manipulated on a micron scale
- Dissects 15–20 males per device
- Collects 100s of sperm cells per male

**Sperm Proteome Composition**

- Activated sperm and MO have unique proteomic signatures
- Major Sperm Protein most abundant
- Identified uncharacterized, nematode-specific proteins in MO
- Conservation of composition between species

**Major Sperm Protein Evolution**

- Hyper-conservation of the gene sequence
- Rapid gene family evolution

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What Determines Fertilization Success?

**Goal:** To quantify the relative importance of post-insemination dynamics in determining total reproductive success using experimental evolution.

- **Male reproductive success = successfully mate + successfully fertilize**
- **female choice**
- **male-male competition**
- **cryptic choice**
- **sperm competition**

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Experimental evolution is a powerful way to study the action of selection and its phenotypic and genotypic consequences.

<table>
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<th>Genetic Transformations for Inducible Sterility and Inducible Lethality</th>
<th>Symbol</th>
<th>Molecular Mechanism</th>
<th>Phenotype</th>
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Experimental Design

- **Post-insemination Competition**
  - Generation 1: 24 hours
  - Generation 2: 48 hours

- **No Competition**
  - Generation 1: 24 hours
  - Generation 2: 48 hours

- **Full Competition**
  - Generation 1: 24 hours
  - Generation 2: 48 hours

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- **Capitalizing on the genetic power of *C. elegans* to completely isolate post-insemination**
- **Select for sperm defensive capability and longevity**
- **Ancestral population is an outcrossed wild isolate**
- **Evolve populations of thousands of worms for tens of generations and measure the phenotypic and genomic changes due to sexual selection**

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