Radiation exposure in the laboratory during pregnancy

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Will my baby turn out to be a potential Marvel superhero?
The short answer is “No”
How is the pregnant worker exposed?

- Pregnant workers and those planning to become pregnant should be careful on being exposed to reproductive hazards.
  - affect the overall health of the mother
  - reduce the delivery of nutrients to the fetus.
- Radiation can pass directly through the mother’s body to her eggs or the fetus
  - **External irradiation**
    - Where practicable, radiation dose may be minimised by reducing the handling time and/or using forceps to increase the distance
  - **Internal irradiation**
    - Inhalation (volatile radioisotopes)
    - contact with the skin (contamination; produces further external exposure),
      » Open wounds
    - Ingestion

*Know Your Exposure*
Effects of radiation exposure

- Radiation damage starts at the cellular level
- When ionizing radiation comes in contact with a cell:
  - It may pass directly through the cell without causing any damage.
  - It may damage the cell but the cell will repair itself.
  - It may affect the cell’s ability to reproduce itself correctly, resulting in a mutation.
  - It may kill the cell.
- The human embryo or fetus is protected in the uterus
  - radiation dose to a fetus tends to be lower than that to its mother
  - however, they are more sensitive to ionizing radiation,
    - health consequences of exposure can be severe, even at radiation doses too low to immediately affect the mother.
## Prenatal Radiation Exposure

<table>
<thead>
<tr>
<th>Gestational age</th>
<th>&lt; 50 mSv</th>
<th>50 – 500 mSv</th>
<th>&gt; 500 mSv</th>
</tr>
</thead>
</table>
| **Blastogenesis** | 0 – 2 wks | • Embryo is resistant to malformation effects  
• Requires exposures much >50 mSv to cause a miscarriage |  |
| **Organo genesis** | 2 – 7 wks | Possible malformations, growth retardation | Increased incidence of miscarriage, growth retardation, neurological & motor deficiencies |
| **Feto genesis** | 8 – 15 wks | Possible IQ reduction, mental retardation | Increased incidence of miscarriage, Possible malformations, growth & mental retardation, IQ reduction (>15 points) |
|                 | 16 – 25 wks | No measurable risks | Increased incidence of miscarriage, neonatal death |
|                 | 26 – 38 wks | No measurable risks |  |

Data referenced from the ICRP, 84, 90  
Hereditary Effects of Radiation, UNSCEAR 2001 Report to the General assembly, with Scientific Annex
What does the regulations says?

Radiation Protection (Amendment) Act 2014
Radiation Protection (Ionising Radiation) Regulations 2000

- **Radiation workers:**
  - 20 mSv per year,
    - averaged over defined periods of 5 years,
    - < 50 mSv in any single year.

- **Members of the public:**
  - 1 mSv per year, not including medical examinations

- **Pregnant workers:**
  - 2 mSv for the remainder of the pregnancy
How to Prevent /Limit your exposures?

• **Preventing:** almost = changing your job!

• **Minimizing risks is the more appropriate.**
  – Esp imp for pregnant women due to the sensitivity of the fetus to specific chemicals, biological agents and ionizing radiation.
  – Lab personnel should know the hazards of the materials that they are working with. (T/D/S)
    • Labels, SDSs, vendors, literature,

• **Adhere to your laboratory safety guidelines.**
  – Safe laboratory practices minimize exposure for all laboratory staff and also protect the developing fetus in pregnant workers.
  – Avoid skin contact; Put on your PPEs
    • Wash hands after contact with hazardous substances and before eating/ drinking

• **Do not bring contamination home**
  – Change out of work clothing
  – Store ‘home’ clothes separately in the workplace to prevent contamination
  – Wash work clothing separately from other laundry (at work if possible)
  – Avoid bringing contaminated clothing or other objects home.
What happens when you declare your pregnancy?

- **Pregnancy Declaration**
  - 1st trimester → most radiosensitive time for a fetus
  - Faculty conducts assessments, implements specific precautions
    - To meet with the Radiation Safety officer to confidentially assess the likely dose to the fetus from each work activity
      - Radio-isotope specific guidelines
      - Information on pre-natal radiation exposure
      - Reviewing past monitoring records
      - 2nd personal dose monitor
    - Exceptional cases: If assessment → risk > 2 mSv
      - To discuss change in work practice / duties

- **A pregnant women who does not declare her pregnancy is protected under the regulations for adult radiation workers.**

- **Not mandatory**
## Occupational reproductive hazards

- **Workplace reproductive hazards:**

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Potential effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strenuous physical activities (e.g., prolonged standing)</td>
<td>Miscarriage, premature delivery</td>
</tr>
<tr>
<td>Lead</td>
<td>Infertility, stillbirths, miscarriage, developmental disorders</td>
</tr>
<tr>
<td>Teratogens and fetotoxic chemicals (lead, ethanol, thalidomide, ethisterone, testosterone, retinoic acid, tetracycline, chemotherapeutic agents and certain ethylene glycol ethers)</td>
<td>Infertility, miscarriage, birth defects, low birth weight</td>
</tr>
<tr>
<td>Ionising Radiation (Depending on the gestational age during exposure)</td>
<td>Infertility, miscarriage, birth defects, developmental disorders, childhood cancers</td>
</tr>
</tbody>
</table>
Reproductive variables

- High levels of physical or emotional stress
  - Affecting menstrual cycle regularity, ovulation

- Diet, lifestyle, environment, viruses, certain chemicals
  - malnutrition,
  - smoking,
  - alcohol / drugs, etc

- History of previous pregnancies
  - including a history of congenital malformations

- Maternal / paternal age
General

• **Background risks**
  – For all healthy pregnant women with no personal or family hx of reproductive problems
    • 3% risk of defects
    • 15% risk of miscarriage

• **Infertility:**
  – About 10 - 15% of couples are unable to conceive a child after 1 year of trying

• **Adverse pregnancy**
  – Statistically, 3 in 10 pregnancies will result in an adverse outcome with no additional radiation exposure.
  – A radiation dose of 50 mSv increases this by about 0.17%

• **Likelihood of Not Developing Childhood Cancer**

<table>
<thead>
<tr>
<th>Radiation Exposure</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>With no radiation exposure</td>
<td>99.93%</td>
</tr>
<tr>
<td>With 50 mSv radiation exposure</td>
<td>99.12%</td>
</tr>
</tbody>
</table>
The final answer is still “No”
Other concerns

- **Radiation exposures to sperm**

<table>
<thead>
<tr>
<th>Procedure type</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birth defects</strong></td>
<td><strong>Infertility</strong></td>
</tr>
<tr>
<td><strong>Diagnostic</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Therapy</strong></td>
<td>No</td>
</tr>
</tbody>
</table>
Thank you for your attention