

# Safety During Pregnancy at the Technion Laboratories



ד"ר' אסתי מסר

**The Technion is committed to  
providing employees and students with  
a safe and healthy environment for  
work and study.**



## חוקים ותקנות הקשורים לחומרים מסוכנים ועבודת נשים בהריון

### PROTECTIVE LABOR LEGISLATION FOR WOMEN IN ISRAEL

- "חוק תקנות נשים (עבודות אסורות, עבודות מוגבלות ועבודות מסוכנות), 2001".
- תקנות הבטיחות בעבודה (ניטור סביבתי וניטור ביולוגי של עובדים בגורמים מזיקים), התשע"א-2011.
- רשימת גורמים הידועים או חשודים כטרטוגנים בבני-אדם, מסמך של ועדה בין משרדית, 2017.
- רשימת גורמים הידועים או חשודים כטרטוגנים בבני אדם – רשימה לא רשמית שהתקבלה מאוניברסיטה העברית בירושלים.



# Objectives

- **To ensure** a *good* and *safe* working environment so that a pregnant employee (staff or student) can safely continue working throughout her pregnancy (faculty/unit as a safe workplace).
- **To protect** both the pregnant woman and the fetus.
- **To enable** pregnant women continue research and/or work tasks for as long as possible.
- **To specify** the options for pregnant women to organize their work with maximum consideration for their pregnancy



# Employee Responsibility

- The first trimester of pregnancy are the **most vulnerable period**. The employer should be informed of the pregnancy **as early as possible (employee's responsibility)**.
- Employers obviously cannot live up to their responsibility **before they know** of the pregnancy!
- It is the pregnant woman's PI (Lab manager or department head) who - in cooperation with the Safety & Radiation Unit (SRU) reps if necessary - is responsible for the pregnant woman's work being planned and carried out in safe conditions that do not pose a hazard to the pregnant person or the fetus.
- Employers can seek help and guidance from the SRU's staff, safety consultants, occupational health clinics, etc.



# Employers' Responsibilities

- **Perform a Risk assessment** - Basically, the employer should always perform a risk assessment covering both the impact of the hazard and its expected level and duration.
- **Reduce the Risk** - If the employer determines that a risk is present he/she must do the following to reduce the risk, in order of priority:
  - **Adjust** or **modify** the physical workplace or, if this is not sufficient or possible
  - **Change** the planning and organization of work or, if this is not sufficient or possible
  - **Move/Transfer** the pregnant woman to other tasks or, if this is not sufficient or possible
  - **Decide** that the pregnant woman **should not** carry out the specific line of work.





# Risk Factors in the Lab

- Physical Risk Factors
- Chemical Risk Factors
- Biological Risk Factors



# Physical harmful effects to be avoided:

## Ergonomics

- Situations where there is increased risk of falling.
- Going up ladders.
- Switching between seating and walking/standing positions (from ~ 13 weeks gestation).
- Lifting loads heavier than 10-12 kg (from ~ 13 weeks gestation).
- Dragging and pushing off loads (from ~ 20 weeks gestation).
- Lifting more than 5-6 kg (from ~ 25 weeks gestation because of the increased distance to the load).

## Vibrations

- Exposure to intense whole-body vibrations (centrifuges, large stirrers).

## Heat

- Extreme heat (  $> 35^{\circ} \text{C}$  ).





# Physical Effects

## Audio/Noise and US

- The hearing of the fetus is developed in the **second half of pregnancy**.
- The hearing of the fetus may be damaged due to **strong low-frequency noise** (below 500 Hz).
- Noise is reduced by crossing the skin, abdominal wall, uterus and amniotic fluid to the fetal ears.
- This noise attenuation is very small at **low frequencies**.
- Pregnant women should therefore **not be exposed** to loud noise at low frequencies (**below 500 Hz**).



# Physical Effects

## Sound - US

- The **audible range of sound** (20-18,000 Hz) does not pose a risk to the fetus.
- Pregnant women should avoid direct contact with ultrasound (US) , i.e. **frequencies over 18,000 Hz.**
- US is suspected as hazardous to pregnancy since a direct contact with high pitched sounds can damage biological tissue.
- The fetus is therefore not exposed to ultrasound damage if the pregnant women does not make direct contact with objects that conduct ultrasound.
- This often means that the pregnant women **cannot carry out sonication.**



# Physical Effects

## Sound - Ultrasound

- Ultrasound (US) imaging **introduces energy** into the body.
- Diagnostic levels of US can produce **physical effects** inside tissues, such as **pressure oscillations** with subsequent **mechanical effects** and a **temperature rise**.
- Therefore, FDA recommends to **minimize US exposure** while maintaining diagnostic quality.
- The principles of **As Low As Reasonably Achievable (ALARA)** should be practiced by health care providers.



# Ionizing Radiation during Pregnancy

- **Declare pregnancy** to the Technion Safety and Radiation Unit (TSRU).
- An institution is not liable to protect a pregnant radiation employee unless she has officially acknowledged her pregnancy.
- Once a declaration has been filed, the fetus is treated like a member of the general population.
- Ionizing radiation can trigger an array of ailments in an unborn child, since ionizing radiation can mutate DNA or cause cell death.
- Studies have shown that this occurs at radiation exposure levels which are typically not reached when proper occupational protection is practiced.



# Ionizing Radiation during Pregnancy

## National council on Radiation Protection's (NCRP) occupational radiation fetal dose recommendations:

- 5 mSv during an entire pregnancy.
- 0.025 mSv/d. limit during pregnancy.
- < 0.5 mSv/m.
- < 1 mSv fetal exposure during an entire pregnancy.
- An expectant woman should only continue to work in a radiation setting of her own volition, not because an employer mandates it.



# Ionizing Radiation during Pregnancy

- The most precarious time for a fetus to suffer the negative effects of radiation are weeks 8 - 15 of gestation, when its organs and nervous system are forming.
- Research has shown that defects can occur at levels of 100 mSv- 200 mSv
- Exposure to 200 mSv – 250 mSv @ 2-15 weeks of gestation – risk for developing childhood cancer.
- Exposure to  $> 100$  mSv – increases frequency of childhood cancer, small head size, seizures and reduced IQ



## קרינה מייננת:

- הדעה הרווחת היום היא שמנת קרינה מייננת לעובר בשיעור של פחות מ 5 ראד איננה גורמת למומים מולדים, הפרעה בגדילה תוך רחמית או הפלות.
- חשיפה של העובר לכמות קרינה העולה על 10 ראד בשלב יצירת האברים כרוכה בתוספת סיכון למומים מולדים.
- בחשיפת העובר לקרינה העולה על 15 ראד מתוארת עלייה של פי 2-3 בשכיחות של מומים מולדים (בעיקר מומים של מערכת עצבים מרכזית, עיניים ושלד) בהשוואה לצפוי באוכלוסייה הכללית. במרבית הפרוצדורות האבחנתיות אין מגיעים לרמת קרינה מסוכנת לעובר אולם יש לבחון כל מקרה לגופו.
- קרינה בכמות משמעותית יכולה להעלות את הסיכון להפלות, למומים מולדים, להפרעה בגדילה התוך רחמית ולנזק נוירוהתפתחותי, כולל פיגור שכלי, בהתאם לשלב ההריון בו הייתה החשיפה לקרינה.
- במקרים של חשיפת העובר ליוד רדיואקטיבי יש לקחת בחשבון גם את האפשרות לנזק בלתי הפיך לבלוטת התריס העוברית (כתלות במינון ובשלב ההריון).



## Probability of Congenital Malformation or Cancer From Conceptus Dose<sup>3</sup>

Conceptus Dose (mSv)	Increased Chance of Congenital Malformation (%)	Increased Chance of Cancer (%)
0.5	0.001	0.004
2.5	0.005	0.022
10.0	0.2	0.09

## Potential Effects of Radiation Exposure to a Fetus<sup>2,3,47</sup>

The main conditions a fetus may suffer from because of radiation exposure are:

- Cancer.
- Growth retardation.
- Congenital malformations.
- Small head size.
- Reduced intelligence quotient.
- Mental retardation.
- Miscarriage.





# Protection from External radiation

## Cardinal Rules:

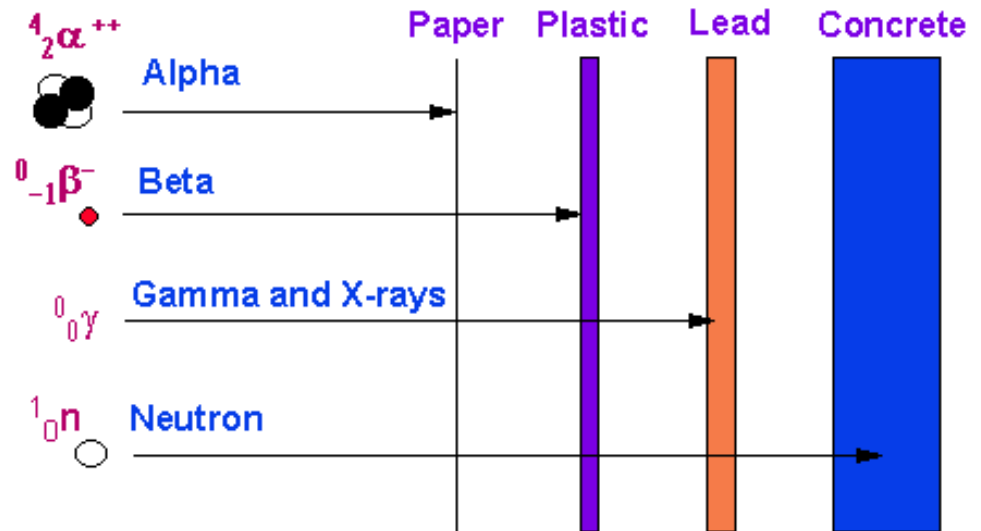
- **PPE (Personal Protective Equipment)**
- **Shielding**
- **Time**
- **Distance**



# Shielding

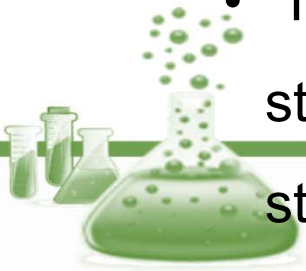
- Alpha particles can be attenuated by a sheet of paper.
- Most Beta particles can be attenuated by 1.5-2 cm of plexiglass.
- Most gamma and x-ray photons can be attenuated by several cm of lead.
- Neutrons may require several feet of concrete or paraffin.

## Penetrating Distances



# Uranyl acetate

- Uranyl acetate is a water-soluble uranium compound (U-238).
- The specific activity of uranyl acetate is 0.17 mCi/gr (6.3 kBq/gr).
- According to the state's regulations it is considered 'radioactive' compound.
- Gamma radiation emitted from uranyl acetate compounds is extremely low.
- U-238 mostly emits Alpha radiation coupled to residual Gamma radiation and minimal Beta radiation.
- The uranyl acetate compound is primarily used for electron microscopy (EM) staining procedures, since it supplies the required contrast for cellular structures differentiation within the EM samples.



# Uranyl Acetate

- The use of minute quantities of uranyl acetate in microscopy involves **both chemical and radiological hazards**, necessitating precautions.
- Characteristic usage of uranyl acetate usually does not pose any danger of **external** ionizing radiation exposure, since the majority of the **Alpha particles** do not penetrate even the human dead skin layer.
- Therefore, the main radiological hazard in working with uranyl acetate entails **internal** exposure, caused by either **ingestion** and/or **inhalation**





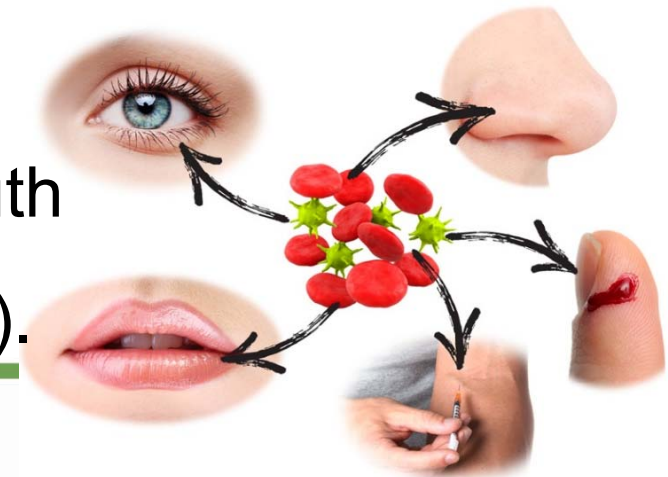
# Risk Factors In the Lab

- Physical Risk Factors
- **Chemical Risk Factors**
- **Biological Risk Factors**



# Potential Routes of Transmission (Chemical & Biological Agents)

- **Inhalation** - hazardous aerosols.
- **Ingestion** – mouth pipetting; eating, drinking around agents' vicinity.
- **Skin Absorption and Mucous membrane exposure**
  - Hazardous/infectious materials in contact with mucosal membranes, such as eyes, nose, mouth (splashes, contact from contaminated surfaces).



# Chemical Effects

- **Chemicals SDS, Container labels and Literature** provide information about the **hazards** of specific chemicals as well as **exempt exposures** to those chemicals.
- **Always read the safety data sheets (SDS) for the individual substances you work with!**



# Chemical Effects

- Be aware that most occupational safety and chemical hazard information considers **regulated exposures to adults with healthy immune systems**.
- In addition, teratogens and fetotoxic chemicals are of special concern for pregnant women.
- Hundreds of chemicals have been identified as having teratogenic effects, a few examples include: **lead, ethanol, thalidomide, ethisterone, testosterone, retinoic acid, tetracycline, chemotherapeutic** agents and certain **ethylene glycol ethers**.





# Chemical Effects

The employer must perform risk assessment for pregnant women, including their fetuses, when working with or being exposed to drugs and materials with the following

**Risk & Health** phrases on labels:

- **R39**: Danger of very serious irreversible effects
- **R40**: Limited evidence of a carcinogenic effect
- **R45**: May cause cancer
- **R46**: May cause inheritable genetic damage
- **R48**: Danger of serious damage to health by prolonged exposure
- **R49**: May cause cancer if inhaled
- **R60**: May impair fertility
- **R61**: May cause harm to the unborn child
- **R62**: Possible risk of impaired fertility
- **R63**: Possible risk of harm to the unborn child
- **R64**: May cause harm to breast-fed babies
- **R68**: Possible risk of irreversible effects
- **H340**: May cause genetic defects.
- **H341**: Suspected of causing genetic defects
- **H350**: May cause cancer
- **H350i**: May cause cancer if inhaled
- **H351**: Suspected of causing cancer
- **H360**: May damage fertility or the unborn child
- **H361**: Suspected of damaging fertility or the unborn child
- **H362**: May cause harm to breast-fed children
- **H370**: Causes damage to organs
- **H371**: May cause damage to organs



# Chemical Effects

Special attention should also be paid to substances, mixtures or materials in a pregnant women's work environment, which could lead to **skin absorption**.

This applies to the following **R** and **H** Statements:

- **R21**: Harmful in contact with skin.
- **R24**: Toxic in contact with skin.
- **R27**: Very toxic in contact with skin.
- **R39/24**: Toxic, danger of very serious irreversible effects in contact with skin.
- **R39/27**: Very toxic, danger of very serious irreversible effects in contact with skin.
- **R48/21**: Dangerous, serious damage to health by prolonged exposure in contact with skin.
- **R48/24**: Toxic, serious damage to health by prolonged exposure in contact with skin.
- **R68/21**: Dangerous, possible risk of irreversible effects in contact with skin.
- **H310**: Fatal in contact with skin.
- **H311**: Toxic in contact with skin.
- **H312**: Harmful in contact with skin.
- **H370**: Causes damage to organs through prolonged or repeated exposure.
- **H371**: May cause damage to organs.
- **H372**: Causes damage to organs damage through prolonged or repeated exposure.
- **H373**: May cause damage to organs through prolonged or repeated exposure.

Working with the above substances in **their powder or** with liquid substances

**should be avoided**



# Chemical Effects

Substances and materials labelled with either **R** and **H** labels can also have adversary effects on the fetus' cells. Therefore, risk assessment should also be carried out when a pregnant employee works with or is exposed to the following substances and materials:

- Hormone disruptors.
- Liquid substances and organic solutions.
- Pesticides.
- Heavy metals.
- Anaesthetic gases.
- Asphyxiant gases (nitrogen, argon, helium carbon dioxide).



## "חוק תקנות נשים (עבודות אסורות, עבודות מוגבלות ועבודות מסוכנות), 2001".

• אישה בגיל פוריות **לא תעבוד** במקום עבודה שבו מייצרים

**Etretinate**

• תוספת שניה (חומרים מוגבלי עבודה ע"י סף):

1. עופרת ונגזרותיה (Lead and Derivatives).

2. קדמיום ונגזרותיו (Cadmium and Derivatives).

3. כספית אורגנית ונגזרותיה (Organic Mercury and Derivatives)



# "חוק תקנות נשים" (עבודות אסורות מוגבלות ועבודות מסוכנות), 2001 - המשך

## • תוספת שלישית – אסורים בעבודה בייצור אבל ניתן לעבוד בהגבלת סף (חובה ליידע מעביד תוך 10 ימים)

1. ארסן (זרניך) ונגזרותיו האנאורגניות - Arsenic and Inorganic Derivatives ;

2. בנזן – Benzene ;

3. וורפרין - Warfarin ;

4. תלידומיד – Thalidomide ;

5. דיאתיל סטילבסטרול - Diethylstilbestrol ;

6. תכשירים ציטוטוקסים אנטיסרטניים, לרבות:

(1) אנתרציקלינים - Anthracyclines ;

(2) אפיפודופילוטוקסינים - Epipodophyllotoxins ;

(3) וינקא-אלקלואידים - Vinca Alkaloids ;

(4) אנטימטבוליטים כגון: פלואורואוראציל Fluorouracil ;

תיוגואנין Thioguanine ;

מתטרקסאט Methotrexate ;

(5) אלקילטורים כגון: מכלוראתאמין - Mechlorethamine ;

ציקלופוספאמיד – Cyclophosphamide ;

7. אתיל ניטרוזאוריא - Ethylnitrosourea ;

8. ביפנילים פוליכלורנייים - Polychlorinated Biphenils ;

9. רטינואידים לרבות איזורטינואידים - Retinoids-Isoretinoids .



# "חוק תקנות נשים" (עבודות אסורות עבודות מוגבלות ועבודות מסוכנות), 2001" - משך

## תוספת רביעית - ניתן לעבוד בהגבלת סף (חובה ליידע מעביד תוך 10 ימים)

1. ארסן (זרניך) ונגזרותיו האנאורגניות - Arsenic and Inorganic Derivatives ;

2. בנזן Benzene ;

3. תכשירים ציטוטוקסים אנטיסרטניים בצורתם הנוזלית, לרבות:

(1) אנתרציקלינים - Anthracyclines ;

(2) אפיפודופילוטוקסינים - Epipodophyllotoxins ;

(3) וינקא-אלקלואידים - Vinca Alkaloids ;

(4) אנטימטבוליטים כגון: פלואורואוראציל - Fluorouracil ;

תיוגואנין - Thioguanine ;

מתוטרקזאט - Methotrezate ;

(5) אלקילטורים כגון: מכלוראתאמין - Mechlorethamine ;

ציקלופוספאמיד - Cyclophosphamide ;

4. אתיל ניטרוזואוריא - Ethylnitrosourea ;

5. ביפנילים פוליכלוריניים - Polychlorinated Biphenils .

## תוספת חמישית - ניתן לעבוד בהגבלת סף (חובה ליידע מעביד תוך 10 ימים)

1. אתילן אוקסיד - Ethylene-Oxide

2. ויניל-כלוריד - Vinyl Chloride

תכשירים ציטוטוקסים ואנטיסרטניים  
מותרים  
במידה ומוכנים להזרקה



## Chemical Effects – Good Laboratory Practice (GLP)

- **Always read the SDS and the workplace instructions for use for each substance worked with!**
- **Perform Risk assessment** – take into account
  - General Safety** Rules (regulations) must always be followed
  - Amount** of the substance
  - Concentrations** of the substance
  - Duration** of the work.



# Chemical Effects - GLP

## Reduce Risks - Control Exposure to Chemicals:

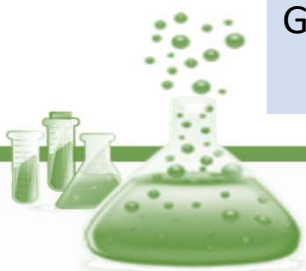
- **Substitute** dangerous substances with other less dangerous substances.
- **Contain** the substance or the process:
  - **USE Engineering solutions:**
    - using a local exhaust system.
    - using a fume hood
  - use **PPE** (clothing, goggles, gloves, respirators etc.).
- **Other options include**
  - purchasing ready-weighed quantities
  - using ready-mixed solutions,
  - using granules instead of powders or kits.





# Reducing risks

Physical properties:	Name	
Liquid	16 % PFA	
Liquid	32 % PFA	
Liquid	20 % SDS Solution	
Granules	SDS Granulated	
Granules	PFA Granulated	



# Chemical Effects - Nanoparticles

## Nanoparticles in the working environment

- During the last 10 years, there has been an increase in the development and application of particulate nanomaterials.
- **In parallel**, suspicions of possible health risks related to exposure to nanoparticles **has risen**.
- There are no regulations regarding labelling and classification of nanoparticles' products.
- **The SRU** recommends to minimize exposure to airborne particles as much as possible and to follow the precautionary principle:
- **Safety precautions**
  - use fume hood, glove boxes or laminar flow benches with a HEPA filter.
  - avoid shuttling dust into the room.
  - PPE.
  - dispose of waste.



# SUMMARY

## Treat all chemicals as potentially hazardous substances:

- Use engineering solutions.
- PPE.
- High frequencies of glove changes.
- Consider splash apron etc..
- When in doubt, ask!





# Risk Factors **i**n the Lab

- Physical Risk Factors
- Chemical Risk Factors
- **Biological Risk Factors**



# Biological Agents and Materials

- A laboratory setting can bring about **Exposure** to biological agents.
- **Reasonable** precautions aim to minimize the risk of accidental exposure to the agents handled. **Mostly**, Good Laboratory Practice (**GLP**) and “**universal precautions**” will be sufficient to adequately control the risks
- However, where there are particular risks associated with some biological agents, **additional precautions** should be applied, **i.e.** cessation of work with such agents for the both the gestation and post-gestational periods.



# Biological Agents and Materials

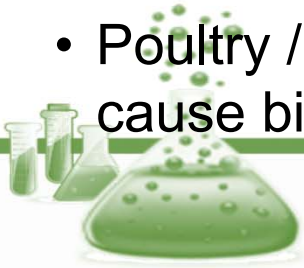
- Many biological agents (mainly within the three biological risk groups: RG2, 3 and 4) can affect the unborn child if the mother is infected.
- These may be transmitted **via the placenta**, **during or after birth**, through **breastfeeding** or through close **physical contact** between mother and child
- There are certain **biological agents** known to cause abortion of the fetus or developmental aberrations.



# Biological Agents and Materials

## Avoid working with research animals, including poultry.

- Experimental animals may pose a fetal risk : they can carry a protozoan, ***Toxoplasma gondii***, which can cause serious or even fatal effects (many people are already carriers).
- It is recommended to consult your physician and perform a blood test to determine if you carry antibodies to the parasite.
- The animals can also be tested.
- If you carry the antibody, then work can continue as before, otherwise you must switch your line of work.
- Poultry / birds can instigate the ***Psittacosis disease*** (parrot disease), which can cause birth defects.



# Biological Agents and Materials

**Do not work with biological agents which are hazardous for pregnant women** (may cause abortion of the fetus or a developmental aberration)

- For example, Listeria (can cause meningitis), Rubella, Toxoplasma, Hepatitis B virus (HBV), HCV, HAV, CMV, HIV, TB, Syphilis, Chickenpox and Typhoid.
- **The Technion's SRU recommends** avoiding work with pathogens specifically during pregnancy, including lentivirus and adeno-associated viruses (AAV).
- Patient specimens - be careful when working with blood and tissue samples. All medical specimens should be considered **potentially infectious** and handled accordingly.
- A vaccination against infectious hepatitis is recommended prior to commencing work with medical specimens, specifically during pregnancy.
- A vaccination against tetanus is recommended for all employees working with animals.





# SUMMARY

## When working with biological agents always -

- Use engineering controls (BSC, local ventilation etc.).
- Always wear appropriate PPE.
- Increase frequencies of glove changes.
- When in doubt, ask.



## Contact Information

BIOHAZARD



### **Biosafety Officer, Dr. Messer Esther**

- For additional biosafety information
- For a one-on-one meeting to answer questions or discuss concerns
- **Safety & Radiation Unit, Tel. 077-8871375.**
- **Mobile: 054-9381035.**
- **<https://safety.net.technion.ac.il/>**





# Any Questions?

