ENERGY IMPACT ON PREGNANCY

**Hyperthermia**
- Hyperthermia promotes in-vivo and in-vitro synthesis of PG
- During hyperthermia inhibition of PG promotes severe acidosis
- Selected PG's induce expression of heat shock proteins (HSP) and induce thermotolerance
- Molecular changes unclear
- Possible role of prostaglandins as protective
- Sheep demonstrate increased prostaglandin plasma levels in mother and fetus
- Inhibition of PG synthesis resulted in fetal death
- Prevent aggregation in the lens (cataract)
- Effect protein folding
- Stabilization of extended chains
- Membrane translocation
- Regulation of heat shock response
- Binding and stabilization/regulation of steroid receptors
- Thermotolerance, proteolysis, resolubilization of aggregates
- Glycoprotein maturation in the ER
- Folding catalysts
- "Quality Control"

**Heat Teratogenesis**
Non-teratogenic doses of ASA potentiate hyperthermic teratogenesis
Arsenicals, vitamin A, ethanol, Lead
Day 8.5 in rate selected - initial phase of organogenesis
Impairments if somitogenesis (axial skeleton)
Dysraphia of rostral neuropore (exencephaly)
Dose response relationship
Axial skeleton has lower threshold (43°)
79.6% vs. 9.6%
Sensitivity of neural tubes is strain dependent

**Ultrasound**
- Sound absorbed differently by different media
- Process not well understood
- Temperature rise may be major effect
- Thermal conductivity
- Frequency
- Heat capacity
- Physiotherapy
- Several degrees in 10 minutes
- Total rise over 10 degrees in small volume
- Experimental Pulse Echo >250watts/cm2
- No gross effects on fetal development
- Intracellular effect
- Levels tested are 100 times greater than in clinical use
- Possible effect of U/S on DNA
- In use >40 years for fetal imaging without any obvious issues
- Most women have >2 U/S per pregnancy
- 40% of All U/S is for OBS use
- Grayscale, B-Mode, 3D, Harmonic imaging, simultaneous multigate imaging
- General belief that it is safe
IN SUMMARY

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- Amplitude reduction as u/s wave enters tissue
- Energy is transferred
- Absorption – conversion into heat
- Scatter – part that changes direction
- Thermal indices
- Soft tissue (TIS)
- Bone (TIB)
- Cranial bone (TIC)

**Role of Bubbles**
- Occurrence of gaseous bubbles in air-water interface
- Transient – violent activity with hot spots
- High temperature
- High pressure
- Both
- Short bursts (microseconds)
- Stable
- Gaseous body oscillates due to presence of US field
- Fluid near bubble starts to flow
- Produces enough stress to disrupt cell membranes

**Hyperthermia is proven teratogen**
- Biologic tissue exposed to us can produce heat and temp rise
- General threshold is 1.5-2°C above maternal core before teratogenicity
- An increase of 2.5-5°C can occur within an hour
- With modern US machine we never see a rise more that 1°C
- No evidence of effect below 39°C
- “diagnostic exposure that produces an in situ rise of no more than 1.5° above normal levels may be used without reservation on thermal grounds”
- “a diagnostic exposure that elevates embryonic and fetal in situ temperature above 41°C for 5 minutes should be considered potentially hazardous.”

- Soft tissue first to be produced embryologically
- Temp rise can be predicted
- Skeleton produced later – no boney effects in first weeks of gestation
- Routine B-mode never causes rise of more than 1.5°C
- In first trimester however there may be greater exposure because of lack of bone protection

**Prospective studies - animal only or tissue culture**
- No difference in malformations, abortions, stillbirth
- Possible reduction in growth
- Growth gap gone after 3 months

- Few studies dealing with chromosome anomalies and U/S
- Little or no change with one exceptional study
- No epidemiologic data
- Unethical not to perform U/S on a pregnancy
- No difference in childhood malignancies
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**Microwaves**
Effects studied with no effects
- Fish tail tissue
- Mouse testes
- Mouse hepatocytes
- Human erythrocytes
- Firefly light organ
- Drosophila larvae
- Amphibian embryos
- Chick embryos
- Mouse ovaries
- Rat thymus
- Mouse CNS
- Human lymphocytes

**Electromagnetic Fields**
- Increasing generation of electric power during this century is not associated with a concomitant rise in the incidence of birth defects
- Over 70 EMF research projects dealing with animal and in vitro studies that are concerned with some aspect of reproduction and growth
- Large proportion of the embryology studies utilized the chick embryo and evaluated the presence or absence of teratogenesis after 48 to 52 hours of development
- Results of chick embryo data are inconsistent
- Embryo culture or cell culture studies are of little assistance in determining the human risk of EMF
- In vitro or in vivo studies in nonhuman species can be used to study only mechanisms and the effects that have been suggested by human investigations

**Video Display Terminals**
No evidence of harm in humans due to VLF radiation

<table>
<thead>
<tr>
<th>FUNDAMENTAL QUESTIONS</th>
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<tbody>
<tr>
<td>1. What teratogenic effects are known to result from hyperthermia?</td>
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<td>2. What does the temperature/effect curve look like?</td>
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<td>3. Is there a clinical temperature above which a pregnant woman should not be permitted to reach?</td>
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<td>4. Describe the tissue effects of ultrasound energy?</td>
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<td>5. At what energy levels can one begin to see effects?</td>
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<td>6. Are there any demonstrated clinical effects of diagnostic ultrasound?</td>
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<td>7. Are there any risks in living near microwave towers?</td>
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<td>8. Describe the possible mechanism of action of microwave teratogenesis</td>
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