

Biological Effects of Radiofrequency Fields

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**Radiofrequency radiation (RFR)
has a very complicated interaction
with biological tissues. Effects
depend on many factors, e.g.,
frequency of the radiation,
duration of exposure, waveform,
etc.**

Considerations

Do different modulations and wave characteristics affect biological systems differently?

Long-term vs acute exposure

Localized vs whole body exposure

Do modulations and different wave characteristics affect biological responses?

-an important consideration to understand biological effects of RFR and radiation from wireless technologies- different technologies have different wave characteristics.

**-examples of modulation-dependency:
D'Ambrosio (02); Huber (02); Hung (07)**

Do different modulations and wave characteristics affect biological systems differently?

Long-term vs acute exposure

Localized vs whole body exposure

Long-term vs acute exposure

Are effects cumulative?

Do responses change with duration/frequency of exposure? Do adaptation and break down of homeostasis occur?

Do different modulations and wave characteristics affect biological systems differently?

Long-term vs acute exposure

Localized vs whole body exposure

Localized vs whole body exposure

-simulation of cell phone use and exposure to radiation from transmission towers

-tissue/organ specific responses

Effects

- (1) Genetic effects**
- (2) Reproduction/sperm effects**
- (3) Brain cells (morphology and cell death)**
- (4) Brain electrophysiology/functions**
- (5) Free radical involvement**
- (6) Low intensity effects**

Genetic Effects

Aitken [05]; Belyaev et al. [05, 06]; D'Ambrosio [02]; Diem [05]; Ferreira [06]; Gadhia [03]; Gandhi and Anita [05]; Gandhi and Singh [05]; Lixia [06]; Markova [05]; Mashevich [03]; Nikolova [05]; Paulraj and Behari [06]; Phillips [98]; Sarimov [04]; Sun [06]; Sykes [01]; Tice [02]; Zhang [06]; Zotti-Martelli [05]

Reproduction/Sperm Effects

Agarwal (07); Aitken (05); Dasdag (99); Erogul (06); Forgacs (06); Fejes (05); Falzone (07); Ozguner (05); Panagopoulos (04, 07); Wdowiak (07); Weisbrot (03); Yan (07)

Brain Cells (morphology and cell death)

Markkanen (04); Marinelli (04); Nikolova (05); Panagopoulos (06); Persson (97); Salford (03); Zheo (06); Zmyslony (04)

Brain Electrophysiology/Functions

**Von Klitzing [95]; Mann and Roschke [96]; Eulitz [98];
Freude [98]; Borbely [99]; Freude [00]; Huber [00] Hietanen
[00]; Krause [00]; Lebedeva [00]; Jech [01]; Lebedeva [01];
Huber [02]; Croft [02]; D'Costa [03]; Huber [03]; Aalta [06];
Kramarenko [03]; Marino [03]; Hamblin [04]; Hinrich and
Heinze [04]; Krause [04]; Papageorgiou [04]; Vorobyov [04];
Curcio [05]; Huber [05]; Loughran [05]; Ferreri [06]; Krause
[06] Papageorgiou [06]; Krause [07]; Vecchio [07]; Hung [07]**

Low Intensity Effects

(whole body exposure, transmission towers)

(0.0015 – 0.02 W/kg)

**de Pomerai (03); Dutta (89); Fesenko (99); Forgacs (06);
Ivaschuk (99); Kwee (01); Lebedeva (00); Magras and Xenos
(99); Mann (98) ; Marinelli (04); Navakatikian and
Tomashevskaya (94); Nittby (07); Novoselova (99); Novoselova
(04); Persson (97); Phillips (98); Polonga-Moraru (02);
Pyrpasopoulou (04); Salford (03); Sarimov (04); Schwartz (90);
Somosi (91); Stagg (97); Stankiewicz (06); Velizarov (99);
Wolke (96); Yurekli (06)**

Cell Phone Biological Studies

	Effect	No Effect	Total
Industry-Funded	27 (28%)	69 (72%)	96 (29%)
Non-Industry-Funded	154 (67%)	76 (33%)	230(71%)
Total	181(56%)	145 (44%)	326

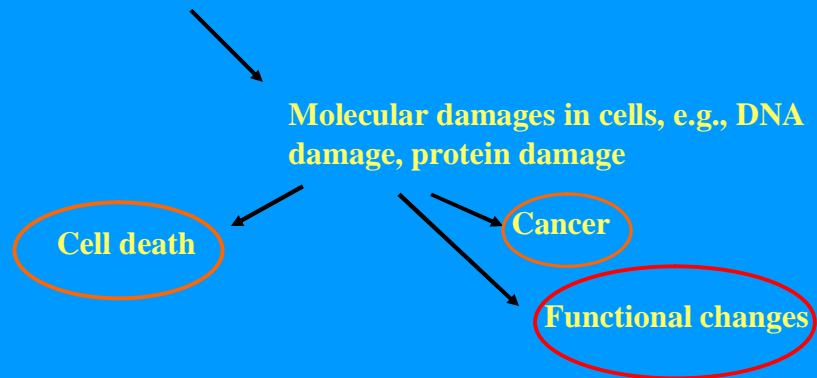
$$\chi^2 = 39.80 (p < .001)$$

Involvement of Free Radicals

-EMF enhances free radical activity and induces oxidative stress/damages in cells

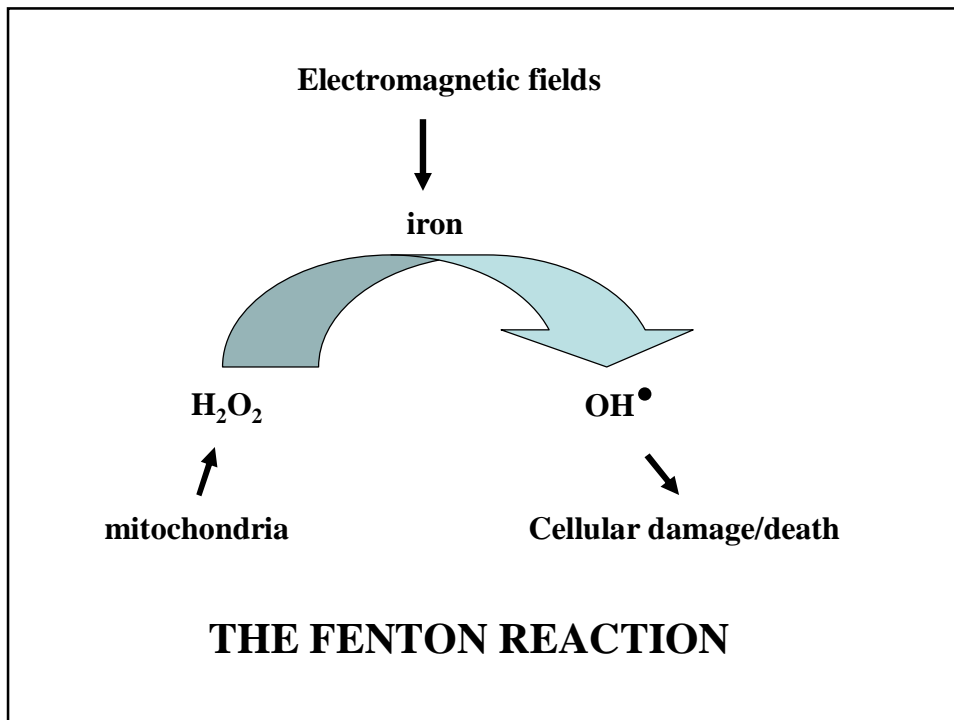
Ayata (04); Balci (07); Friedman (07); Guney (08); Hoyta (08); Ilkan (04); Irmak (02); Koylu (06); Lai and Singh (97a, b, 2004); Moustafa (01); Oktem (05); Oral (06); Ozguner (04, 05, 06); Philippova (94); Stopczyk (02); Yariktas (05); Yurekli (06); Wu (08)

Free radicals



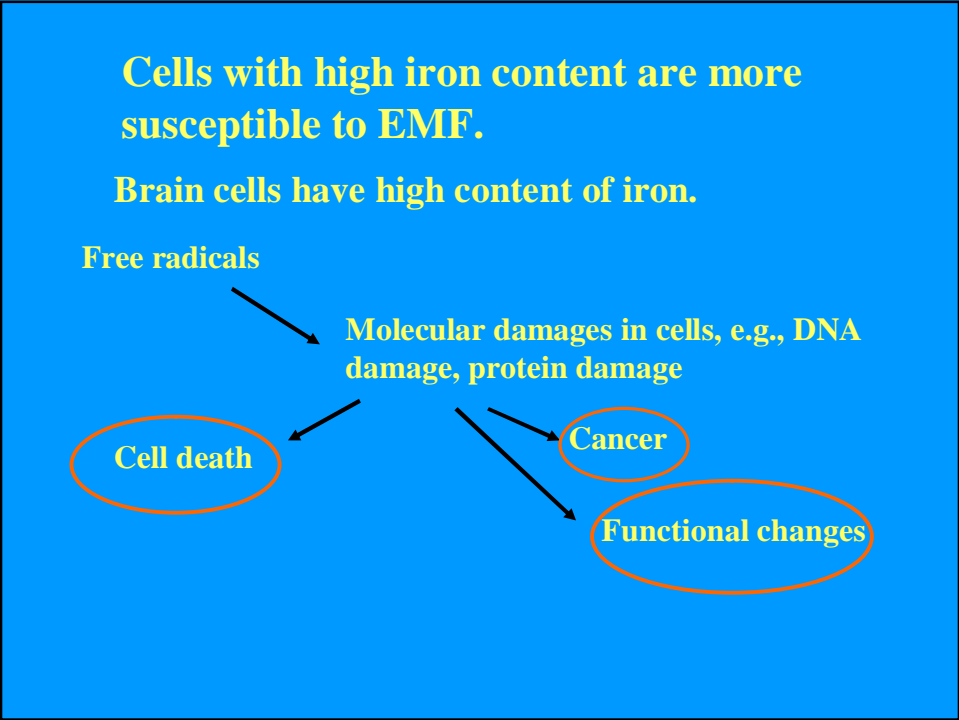
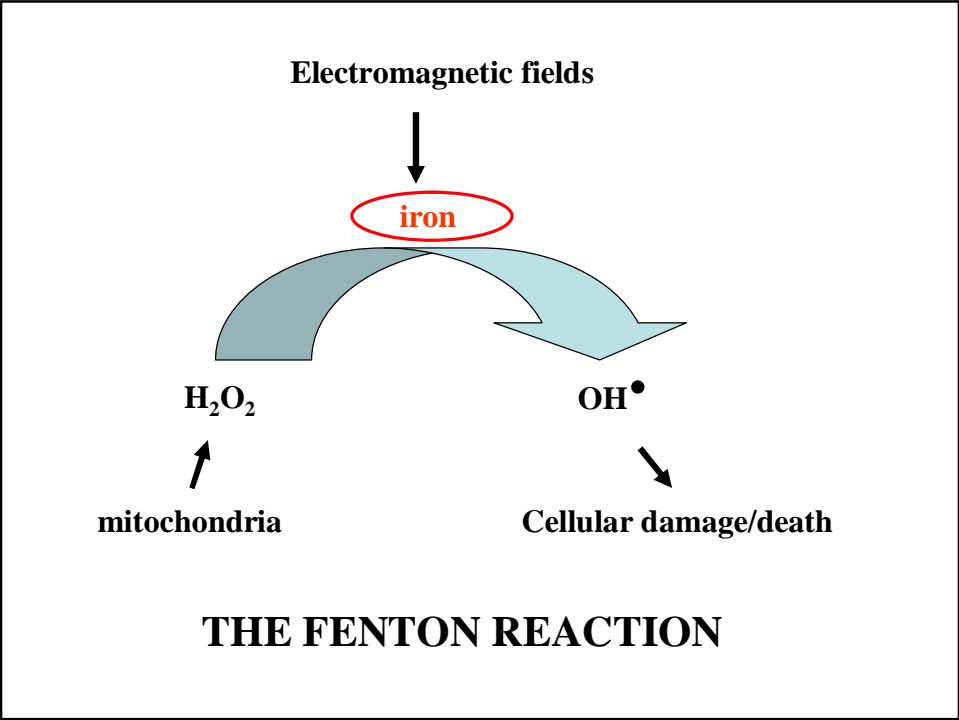
The Fenton Reaction

-an iron-related free radical generation chemical reaction



EMF and the Fenton Reaction

- Adding iron to cells enhances the effect of EMF**
- Removing iron decreases the effect of EMF**



Most cancer cells have much higher concentration of iron than normal cells. EMF selectively kills cancer cells.

Ideal criteria of cancer treatment:

- (1) Selectively against cancer cells and not harmful to normal cells- low adverse side effect.**
- (2) Effective at low levels (intensity or dosage).**
- (3) Can be administered easily with little Stress/discomfort to the patient.**
- (4) Economical**