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); Somosy (91); Stagg (97); Stankiewicz (06); Velizarov (99); Wolke (96); Yurekli (06)

Cell Phone Biological Studies

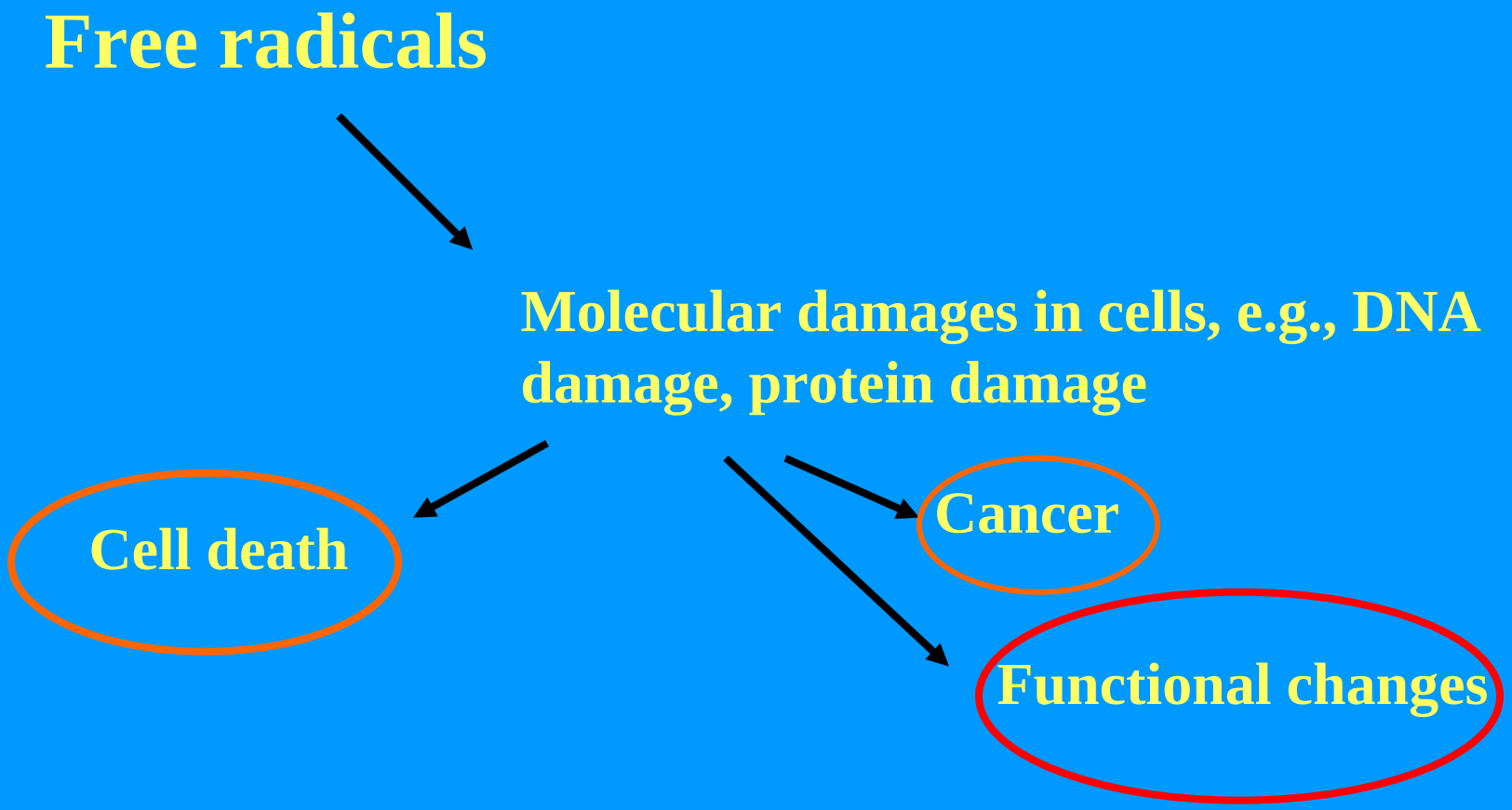
	Effect	No Effect	Total
Industry-Funded	27 (28%)	69 (72%)	96 (29%)
Non-Industry-Funded	154 (67%)	76 (33%)	230 (71%)
Total	181 (56%)	145 (44%)	326

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

Involvement of Free Radicals

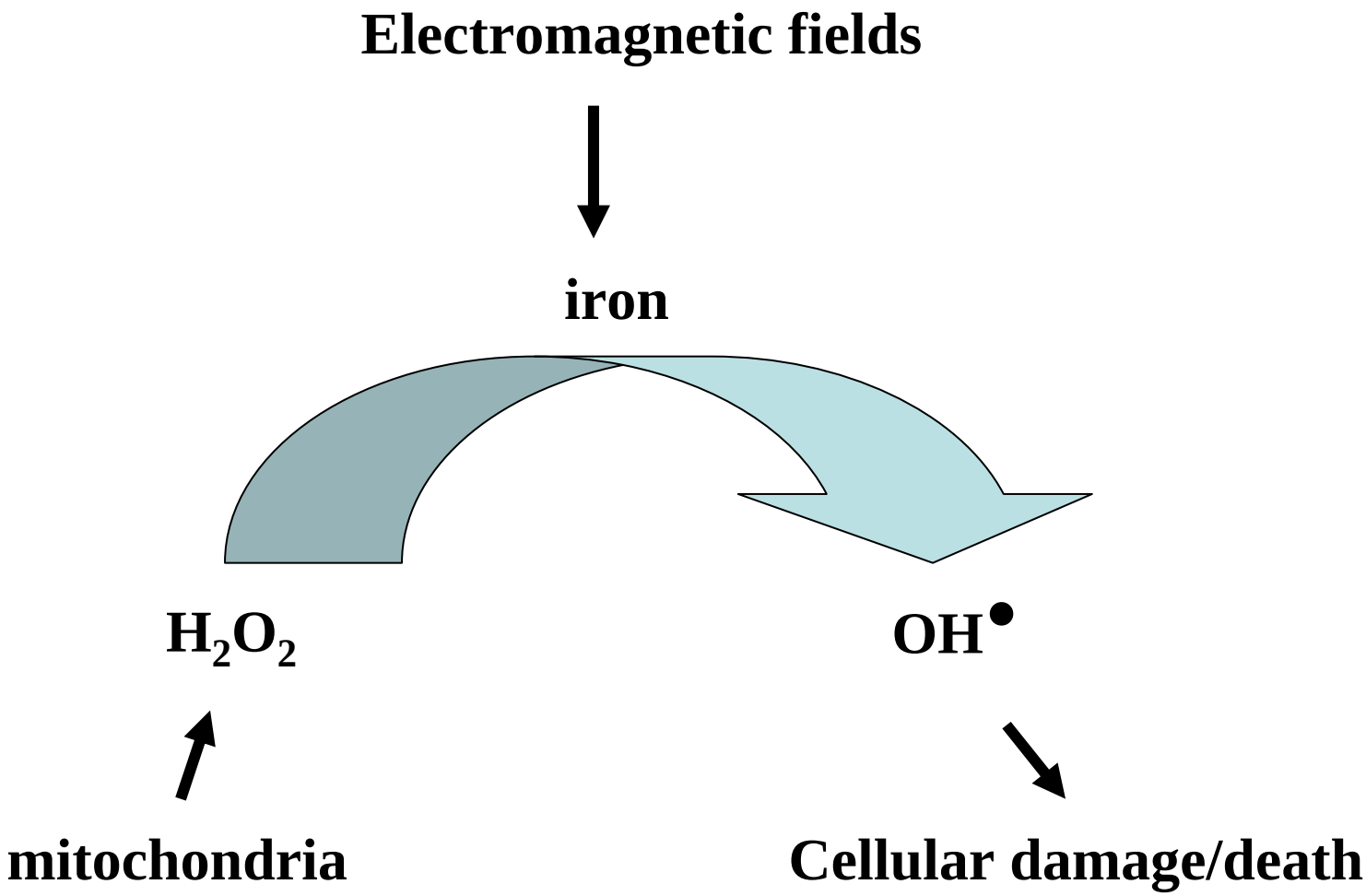
-EMF enhances free radical activity and induces oxidative stress/damages in cells

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
Molecular damages in cells, e.g., DNA damage, protein damage
Cell death
Cancer
Functional changes

The Fenton Reaction

-an iron-related free radical generation chemical reaction

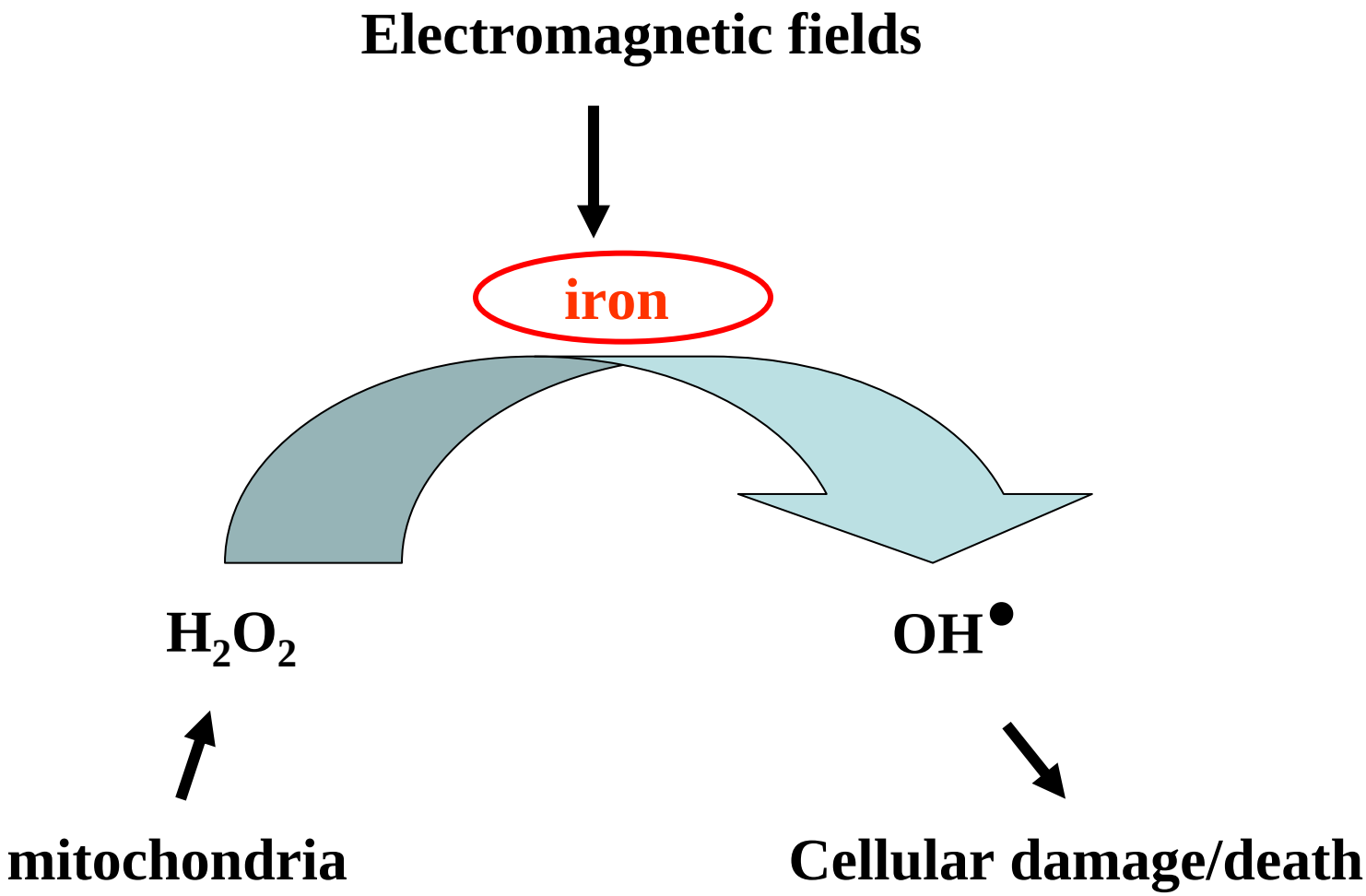


THE FENTON REACTION

EMF and the Fenton Reaction

-Adding iron to cells enhances the effect of EMF

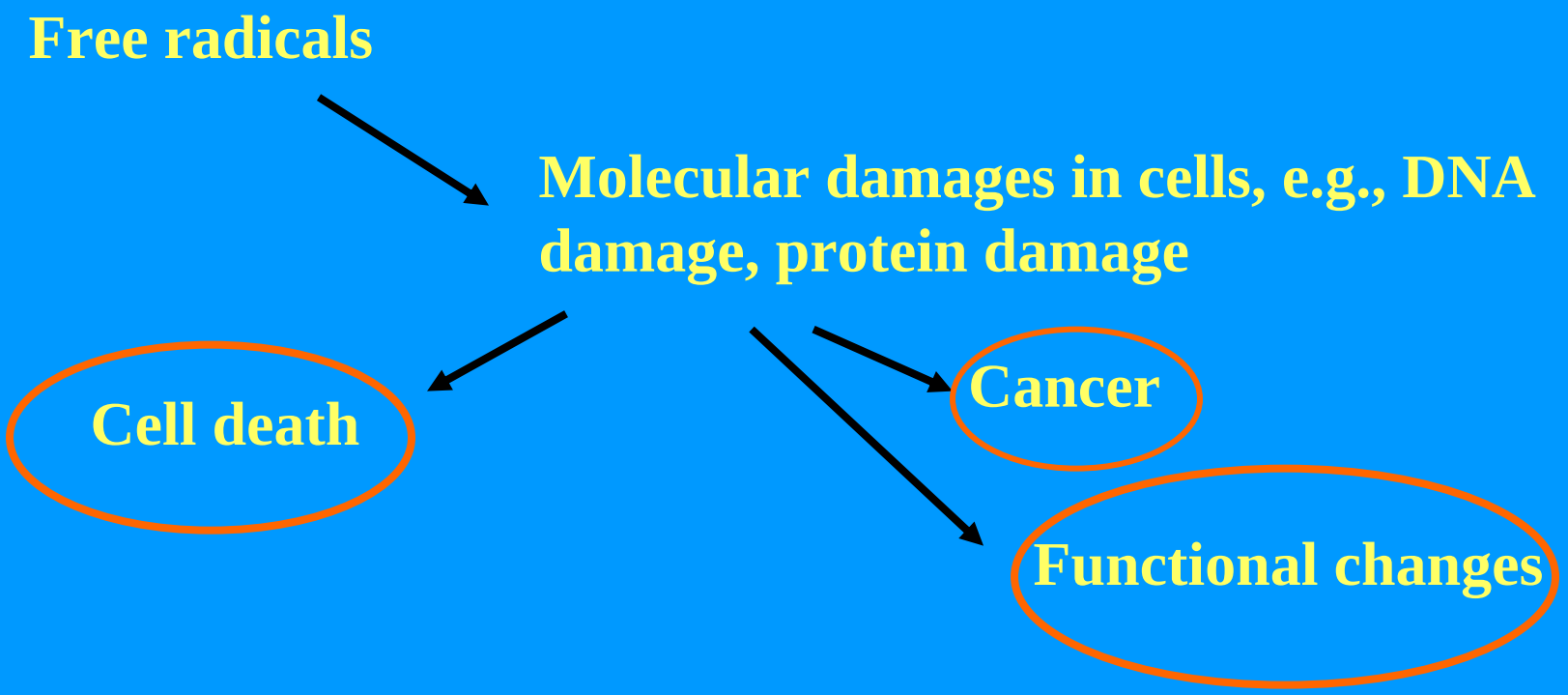
-Removing iron decreases the effect of EMF



THE FENTON REACTION

Cells with high iron content are more susceptible to EMF.

Brain cells have high content of iron.



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