Division of Radiobiology and Radiohygiene

Department of Radiation Medicine

Personnel:

Katalin Lumniczky MD, PhD, department head
Renáta Andrejkovics-Szentmihályi, public health officer
Lilla Antal, biologist, BSc (part-time)
Katalin Balázs, biologist, MSc, PhD student
Ilona Csordás, BSc student, public health supervisor (part-time)
Rita Hargitai, biologist, PhD
Dávid Kis, biologist, medical biotechnologist MSc, PhD student
Enikő Kis, biologist, MSc, PhD candidate
Eszter Persa, biologist, PhD
Nikolett Sándor, biologist, MSc, PhD (at present on maternity leave)
Tünde Szatmári, biologist, PhD

Marianna Csabádi-assistant
Károly Haller - assistant

Main tasks of the department

a) We perform research activities in the field of radiation protection and radiation biology. The ultimate goals of our studies are to establish methods for early recognition and proper treatment of potential radiation injuries in humans and to help to promote the exploitation of ionizing radiation in the fields of public health and medicine. Our specific research targets/study objects are 1) methods of detection and modification of radiation injuries 2) the effects of ionizing radiation on the components of human environment 3) the combined effects of ionizing radiation and other physical, chemical and/or biological agents on human health and environment 4) applicability of radiation technology in public health and environmental protection.

b) We contribute to the application of radiobiological effects for radiotherapy and cancer therapy.

c) We participate in the evaluation of individual radiosensitivity and in biodosimetric measurements.

d) We follow and evaluate the Hungarian and international scientific research and innovation in the field of radiobiology, with recommendations on how to adapt their results/outcome in practice.

e) We develop proposals for short- and long-term programs of radiobiology and radiohygiene.

f) We participate in the medical care of radiation injured or potentially injured persons according to the decree 16/2000 (VI.8.) on the implementation of specific regulations of the Act CXVI of 1996 about atomic energy. In case of a potential overexposure we perform biodosimetric measurements, - and uniquely in Hungary, our laboratory is estimating the magnitude of the radiation dose received and of the possible effects.

g) We contribute to the professional training of the personnel of the health institutions assigned to be in charge for the health care of radiation injured or potentially injured persons; we organize regular postgraduate courses in radiation medicine, and give consultations for the professionals from designated health care institutions on the subject of "Professional Care of radiation injuries".

h) We give expertise in case of suspected radiation-related occupational diseases

i) We collaborate in compilation of training materials for radiomedicine training and health education;

j) We participate in the training of radiotherapy specialists

k) We participate in the graduate and postgraduate training courses and other training tasks organized by different Hungarian universities, colleges, and other institutions

l) We also provide individual training possibilities and professional guidance for under- and postgraduate students, including PhD students

m) We participate in the activities of WHO/REMPAN;

n) We regularly participate, give lectures and/or organize various Hungarian and international scientific meetings, seminars and conferences.

o) We publish our scientific research results in international and Hungarian peer-reviewed journals

p) We participate in the implementation of the professional degrees and activities defined by the scientific community at all times and support our employees in achieving these.

q) We host international and Hungarian guest researchers and students.

The financial support of our department are provided by Hungarian and international research grants.

Detailed activities of the Department of Radiation Medicine

A. Research activity

The main research activity of the Division of Radiation Medicine represents the study of cellular and molecular effects of ionizing radiation. A special emphasis is placed on the study of the biological effects of low-dose (below 100 mGy). The number of diagnostic medical examinations (CT, PET, PET-CT, and angiography) which imply low-dose radiation exposure, increased rapidly during the last decade and this tendency continues in the future as well. These procedures affect the population on a wide scale. The doses received during a single intervention are very low, and they will not result in short term health impairment, but the biologic effects can accumulate due to repeated exposures. Low dose induced long-term effects are less well identified. International research groups have shown in several epidemiological studies that even the dose ranges applied in diagnostic examinations can statistically increase the incidence of malignant tumors. Therefore, and due to the increasing number of healthy individuals exposed to low doses, it is very important to elucidate the short- and long-term biological effects of low-dose radiations.

One of the main research activities of our Division is to study the short- and long-term biological effects of low-dose ionizing radiation in various biological systems in the following topics:

One of our main focuses is the study of the non-targeted effects of ionizing radiation. Although the most intensively studied radiobiological consequences of ionizing radiation are still the induction of DNA damage, cell death and the alterations in the directly irradiated cells, in recent years, the focus of radiobiological research has shifted from this purely DNA target-based orientation towards a more dynamic and systemic view. In this novel view, the non-targeted effects of irradiation, including genomic instability and bystander effects, play a major role, and cellular responses, micro/macro-environmental influences, and systemic effects are at least as important as the dose directly absorbed by the cells and the organism. Within this field, we focus on deciphering the role of extracellular vesicles (EVs) in the mediation of ionizing radiation induced short- and long-term effects, ie. bystander and systemic effects in the hematopoietic system as well as the possible role of EVs in the ionizing radiation induced leukemia formation. We have recently shown *in vivo* that similar to direct radiation, EVs from irradiated mice induced complex DNA damage in EV-recipient animals, as well as phenotypical changes in the hematopoietic system and changes in the cytokine pool of peripheral blood. We identified several differentially expressed microRNAs in the EVs originating from both low- and high-dose-irradiated mice with a predicted involvement in pathways related to DNA damage repair, hematopoietic- and immune system regulation. One of the altered signaling pathways was the acute myeloid leukemia pathway, hence in an ongoing project, using a murine model, we study the involvement of EVs in radiation-induced AML.

In a related project we studied low-dose effects on long-term brain damage in murine and rat models. We investigated low-dose irradiation induced damage in blood-brain barrier permeability, radiation induced inflammatory processes affecting the brain microcirculation in general and microvascular endothelial cells in special, and radiation induced mitochondrial dysfunction.

Another important research priority of our Division constitutes the study of bioindicators of ionizing radiation. In an ongoing project we test whether samples collected with non-invasive methods, such as hair or saliva are suitable biomarkers of low-dose local ionizing radiation. Hair seems a suitable sample, it can be collected both from exposed and non-exposed control areas. The hair bulb as well as the hair shaft contains mitochondrial DNA. We study whether the lesions (e.g. strand breaks, abasic sites, TT dimer, O6-Methyl-2'-deoxyguanosine) of mitochondrial DNA isolated from hair samples become more frequent after exposure to low-dose ionizing radiation. In addition, we measure some specific deletions in the mitochondrial DNA, the proportion of which is expected to change after exposure to ionizing radiation. We perform our studies with human and mouse hair samples.

In collaboration with Hungarian and European oncology clinics, we also study the prognostic and predictive markers of disease and therapy response in head-and-neck and prostate cancer patients treated with radiotherapy. Within this topic, in a search for cellular and soluble immunological markers we analyse the secreted cytokines and the pool and function of different peripheral blood mononuclear cell populations of patients before and after radiotherapy and compare the results with values from healthy controls as well.

Funding:

The financial support of our research activities are provided by Hungarian and international, (mainly from European Union) research grants.

Actual grants:

VKSZ_14-1-201S-0021 Nemzeti Nukleáris Kutatási Program (National Nuclear Research Program)

Project owner: Nemzeti Kutatási Fejlesztési és Innovációs Hivatal (National Research, Development and Innovation Office)

Duration: 2014.11.24. - 2018.11.19.

Support: 92 000 000,- Ft

K-124879

Cytogenetic and immunology markers predicting the outcome and late sequel of radiation therapy in prostate cancer patients

Project owner:

National Research, Development and Innovation Office, **NKFI-6**
Duration: 2017-09-01 - 2021-08-31

Support: 15 964 000,- Ft

662287 (CONCERT) European Joint Programme for the Integration of Radiation Protection Research — CONCERT + LEU-TRACK

Project owner: Euratom Research and Training Programme 2014-2018

Duration : 2015-06-01 - 2020-05-31

Support: 408 241,- Euro

B: Biodosimetric measurements and professional expertise in radiation medicine and radiation preparadness

Radiation Biodosimetry Group

The main task of our Biodosimetry Group is dose estimation from human blood samples which are sent to our Institute. These samples come from people injured in radiological accidents or radiation therapy patients..

We also take part in the work of international networks (RENEB, RANET). These networks are built for the management and reciprocal help in the case of an incidental mass casualty caused by ionizing radiation.

We participate in the medical care of radiation injured or potentially injured persons.

In accordance with the decree 16/2000 (VI.8.) on the implementation of specific regulations of the Act CXVI of 1996 about atomic energy, our Division, uniquely in Hungary, in case of a potential overexposure perform biodosimetric measurements, and estimate the magnitude of the radiation dose received and the possible effects.

We perform routinely two types of methods: dicentric chromosome analysis and micronucleus assay.

We participate regularly in the work of the international biodosimetry network, in particular in the laboratory intercomparisons.

C. Teaching activity

- Basic, comprehensive and advanced radiation protection courses organized by Semmelweis University, Budapest and NPHC
- Radiation biology course for radiotherapy specialists and candidates at Semmelweis University, Budapest
- Radiation biology and Gene therapy courses for undergraduate students at the Faculty of Medicine of the University of Pécs
- Postgradual radiation biology courses for radiation physicists at Budapest University of Technology and Economics, Practical training of radiation biology for radiotherapy specialist candidates.

Relevant publications:

2019

1. Balázs K, Kis E, Badie C, Bogdándi EN, Candéias S, Garcia LC, Dominczyk I, Frey B, Gaipl U, Jurányi Z, Kocsis ZS, Rutten EA, Sáfrány G, Widlak P, **Lumniczky** K. Radiotherapy-Induced Changes in the Systemic Immune and Inflammation Parameters of Head and Neck Cancer Patients. *Cancers (Basel).* 2019 Sep 6;11(9).

2. Szatmári T, Hargitai R, Sáfrány G, Lumniczky K. Extracellular Vesicles in Modifying the Effects of Ionizing Radiation. Int J Mol Sci. 2019 Nov 6;20(22). pii: E5527. doi: 10.3390/ijms20225527

2018

2. Persa E, Szatmári T, Sáfrány G, Lumniczky K. In Vivo Irradiation of Mice Induces Activation of Dendritic Cells. *International Journal of Molecular Sciences.* 2018 Aug 14;19(8).

3. Szatmári T, Persa E, Kis E, Benedek A, Hargitai R, Sáfrány G, Lumniczky K. Extracellular vesicles mediate low dose ionizing radiation induced immune and inflammatory responses in the blood. *International Journal of Radiation Biology*. 2018 March 29:1-11

2017

4. Szatmári T, Kis D, Bogdándi EN, Benedek A, Bright S, Bowler D, Persa E, Kis E, Balogh A, Naszályi LN, Kadhim M, Sáfrány G, Lumniczky K. Extracellular Vesicles Mediate Radiation-Induced Systemic Bystander Signals in the Bone Marrow and Spleen. *Frontiers in Immunology.* 2017, 8:347.

5. Lumniczky K, Szatmári T, Sáfrány G. Ionizing Radiation-Induced Immune and Inflammatory Reactions in the Brain. *Frontiers in Immunology.* 2017, 8:517.

6. Sáfrány G. and Lumniczky K. Radiation Therapy and Gene Therapy: a Potential New Combined Modality in the Management of Malignant Diseases. *Central European Journal of Occupational and Environmental Medicine*.2017, 23:240-253.

7. Lumniczky K, Candéias SM, Gaipl US, Frey B. Editorial: Radiation and the Immune System: Current Knowledge and Future Perspectives. *Frontiers in Immunology.* 2017, 8:1933.

8. Kulka U, Abend M, Ainsbury E, Badie C, Barquinero JF, Barrios L, Beinke C, Bortolin E, Cucu A, De Amicis A, Domínguez I, Fattibene P, Frøvig AM, Gregoire E, Guogyte K, Hadjidekova V, Jaworska A, Kriehuber R, Lindholm C, Lloyd D, Lumniczky K, Lyng F, Meschini R, Mörtl S, Della Monaca S, Monteiro Gil O, Montoro A, Moquet J, Moreno M, Oestreicher U, Palitti F, Pantelias G, Patrono C, Piqueret-Stephan L, Port M, Prieto MJ, Quintens R, Ricoul M, Romm H, Roy L, Sáfrány G, Sabatier L, Sebastià N, Sommer S, Terzoudi G, Testa A, Thierens H, Turai I, Trompier F, Valente M, Vaz P, Voisin P, Vral A, Woda C, Zafiropoulos D, Wojcik A. RENEB - Running the European Network of biological dosimetry and physical retrospective dosimetry. *International Journal of Radiation Biology.* 2017 93:2-14.

9. Oestreicher U, Samaga D, Ainsbury E, Antunes AC, Baeyens A, Barrios L, Beinke C, Beukes P, Blakely WF, Cucu A, De Amicis A, Depuydt J, De Sanctis S, Di Giorgio M, Dobos K, Dominguez I, Duy PN, Espinoza ME, Flegal FN, Figel M, Garcia O, Monteiro Gil O, Gregoire E, Guerrero-Carbajal C, Güçlü İ, Hadjidekova V, Hande P, Kulka U, Lemon J, Lindholm C, Lista F, Lumniczky K, Martinez-Lopez W, Maznyk N, Meschini R, M'kacher R, Montoro A, Moquet J, Moreno M, Noditi M, Pajic J, Radl A, Ricoul M, Romm H, Roy L, Sabatier L, Sebastià N, Slabbert J, Sommer S, Stuck Oliveira M, Subramanian U, Suto Y, Que T, Testa A, Terzoudi G, Vral A, Wilkins R, Yanti L, Zafiropoulos D, Wojcik A. RENEB intercomparisons applying the conventional Dicentric Chromosome Assay (DCA). *International Journal of Radiation Biology.* 2017 93:20-29.

10. Depuydt J, Baeyens A, Barnard S, Beinke C, Benedek A, Beukes P, Buraczewska I, Darroudi F, De Sanctis S, Dominguez I, Monteiro Gil O, Hadjidekova V, Kis E, Kulka U, Lista F, Lumniczky K, M'kacher R, Moquet J, Obreja D, Oestreicher U, Pajic J, Pastor N, Popova L, Regalbuto E, Ricoul M, Sabatier L, Slabbert J, Sommer S, Testa A, Thierens H, Wojcik A, Vral A. RENEB intercomparison exercises analyzing micronuclei (Cytokinesis-block Micronucleus Assay). *International Journal of Radiation Biology.* 2017 93:36-47.

11. Brzozowska B, Ainsbury E, Baert A, Beaton-Green L, Barrios L, Barquinero JF, Bassinet C, Beinke C, Benedek A, Beukes P, Bortolin E, Buraczewska I, Burbidge C, De Amicis A, De Angelis C, Della Monaca S, Depuydt J, De Sanctis S, Dobos K, Domene MM, Domínguez I, Facco E, Fattibene P, Frenzel M, Monteiro Gil O, Gonon G, Gregoire E, Gruel G, Hadjidekova V, Hatzi VI, Hristova R, Jaworska A, Kis E, Kowalska M, Kulka U, Lista F, Lumniczky K, Martínez-López W, Meschini R, Moertl S, Moquet J, Noditi M, Oestreicher U, Orta Vázquez ML, Palma V, Pantelias G, Montoro Pastor A, Patrono C, Piqueret-Stephan L, Quattrini MC, Regalbuto E, Ricoul M, Roch-Lefevre S, Roy L, Sabatier L, Sarchiapone L, Sebastià N, Sommer S, Sun M, Suto Y, Terzoudi G, Trompier F, Vral A, Wilkins R, Zafiropoulos D, Wieser A, Woda C, Wojcik A. RENEB accident simulation exercise. *International Journal of Radiation Biology.* 2017 93:75-80.

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13. Casciati A, Dobos K, Antonelli F, Benedek A, Kempf SJ, Bellés M, Balogh A, Tanori M, Heredia L, Atkinson MJ, von Toerne C, Azimzadeh O, Saran A, Sáfrány G, Benotmane MA, Linares-Vidal MV, Tapio S, Lumniczky K, Pazzaglia S. Age-related effects of X-ray irradiation on mouse hippocampus. Oncotarget. 2016, 7:28040-58.

2015

14. Persa E, Balogh A, Sáfrány G, Lumniczky K. The Effect of Ionizing Radiation on Regulatory T Cells in Health and Disease. Cancer Letters 2015 368 252-261, doi: 10.1016/j.canlet.2015.03.003

15. N. Sándor, B. Schilling-Tóth, E. Kis, A. Benedek, K. Lumniczky, G. Sáfrány, H. Hegyesi, Growth Differentiation Factor-15 (GDF-15) is a potential marker of radiation response and radiation sensitivity, Mutat. Res.: Genet. Toxicol. Environ. Mutagen. 2015 793 142-9. http://dx.doi.org/10.1016/j.mrgentox/2015.06.009

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18. Lumniczky K, Sáfrány G. The Impact of Radiation Therapy on the Antitumor Immunity: Local Effects and Systemic Consequences. *Cancer Letters* 2015, 316; 114-25. http://dx.doi.org/10.1016/j.canlet.

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19. Kulka U, Ainsbury L, Atkinson M, Barnard S, Smith R, Barquinero JF, Barrios L, Bassinet C, Beinke C, Cucu A, Darroudi F, Fattibene P, Bortolin E, Monaca SD, Gil O, Gregoire E, Hadjidekova V, Haghdoost S, Hatzi V, Hempel W, Herranz R, Jaworska A, Lindholm C, Lumniczky K, M'kacher R, Mörtl S, Montoro A, Moquet J, Moreno M, Noditi M, Ogbazghi A, Oestreicher U, Palitti F, Pantelias G, Popescu I, Prieto MJ, Roch-Lefevre S, Roessler U, Romm H, Rothkamm K, Sabatier L, Sebastià N, Sommer S, Terzoudi G, Testa A, Thierens H, Trompier F, Turai I, Vandevoorde C, Vaz P, Voisin P, Vral A, Ugletveit F, Wieser A, Woda C, Wojcik A. Realising the European Network of Biodosimetry: RENEB-status quo. *Radiat Prot Dosimetry*. 2014 Sep 9. pii: ncu266.

20. Lumniczky K, Sáfrány G. Potential Radiosensitivity Genes in Primary Human Fibroblasts: a Whole Genome Microarray Study. *Central European Journal of Occupational and Environmental Medicine*. 2014, 20; 41.

2013

21. Balogh A, Persa E, Bogdándi EN, Benedek A, Hegyesi H, Sáfrány G, Lumniczky K. The effect of ionizing radiation on the homeostasis and functional integrity of murine splenic regulatory T cells. *Inflamm Res* 2013, 62: 201-212. DOI 10.1007/s00011-012-0567-y

2012

22. Hargita Hegyesi, Nikolett Sándor, Boglárka Schilling, Enikő Kis, Katalin Lumniczky, Géza Sáfrány. Differentially expressed genes associated with low-dose gamma radiation: Growth Differentiation Factor (GDF-15) as a radiation response gene and radiosensitizing target. Springer Radiation Damage in Biomolecular Systems Biological and Medical Physics, Biomedical Engineering, EDsGarcia and M.C. Fuss: 2012, Part 3, 359-370

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2010

24. Bogdándi EN, Balogh A, Felgyinszky N, Szatmári T, Persa E, Hildebrandt G, Sáfrány G, Lumniczky K. Low Dose Radiation Effects on the Immune System of Mice after Total-body Irradiation. *Radiat Res* 2010, 174: 480-489.

2008

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2006

26. Szatmári T*, Lumniczky K*(shared first-authorship), Désaknai S, Trajcevski S, Hídvégi EJ, Hamada H, Sáfrány G. Detailed characterization of the mouse glioma 261 tumor model for experimental glioblastoma therapy. *Cancer Science* 2006; 97: 546-553.

27. Lumniczky K, Sáfrány G. Cancer Gene Therapy: Combination with Radiation Therapy and the Role of Bystander Cell Killing in the Anti-tumor Effect. *Pathol Oncol Res* 2006; 12:118-24.

28. Kis E, Szatmári T, Keszei M, Farkas R, Ésik O, Lumniczky K, Falus A, Sáfrány G. Microarray analysis of radiation response genes in primary human fibroblasts. *Int J Radiat Oncol Biol Phys* 2006; 66:1506-14.

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29. K. Lumniczky and G. Sáfrány. The bystander effect of cancer gene therapy. In „Non-targeted effects of ionising radiation Proceedings of the RISC-RAD specialised training course. STUK – Radiation and Nuclear Safety Authority, Helsinki, Finland 14 – 16 February 2005 (Ed. O. Belyakov)

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30. Klementis I, Lumniczky K, Kis E, Szatmári T, Antal S, Sáfrány G. The transgenerational mutagenic and carcinogenic effect of ionizing radiation. *Central European Journal of Occupational and Environmental Medicine* 2004; 10: 235-245.

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33. Antal S, Lumniczky K, Palfalvi J, Hidvegi E, Schneider F, Safrany G. Oncogenes and tumor suppressor genes in murine tumors induced by neutron- or gamma-irradiation in utero. RADIATION AND HOMEOSTASIS, INTERNATIONAL CONGRESS SERIES. 1236: 119-122. 2002

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34. Désaknai S, Lumniczky K, Hidvégi EJ, Hamada H, Sáfrány G. Brain tumor treatment with IL-2 and IL-12 producing autologous cancer cell vaccines. *Adv. Exp. Med. Biol*. 2001; 495: 369-372.

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35. Schmidt J, Lumniczky K, Tzschaschel BD, Guenther HL, Luz A, Riemann S, Gimbel W, Erfle V, Erben RG. Onset and dynamics of osteosclerosis in mice induced by RFB murine leukemia virus (RFB MuLV): Increase in bone mass precedes lymphomagenesis. *The American Journal of Pathology* 1999; 155: 557-570

1998

36. Lumniczky K, Antal S, Unger E, Wunderlich L, Hídvégi EJ and Sáfrány G. Carcinogenic alterations in murine liver, lung and uterus tumors induced by in utero exposure to ionizing radiation. *Mol. Carcinogen.* 1998; 21: 100-110

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37. Lumniczky K, Sáfrány G. Simultaneous isolation of both RNA and DNA from many small tissue samples. *Acta Biologica Hungarica*, 1997; 48: 253-257.

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PERSONNEL

KATALIN LUMNICZKY, M.D., Ph.D.

E-mail: lumniczky.katalin@osski.hu
lumniczky.katalin@nnk.gov.hu

Phone: +36-1-482-2010, +36-1-482-2011
+36-30-5549308

Education:

- 1986-1993: medical studies, Semmelweis University, Budapest, Hungary
- graduated as medical doctor
- 1994-1999: PhD studies, Biophysical Faculty, Semmelweis University, Budapest, Hungary
- PhD thesis: The role of ionizing radiation and retorvirus infection in tumorigenesis

Workplaces:

- 1993-1999: research scientist and PhD student at the Dept. of Molecular and Tumour Radiobiology, National Research Institute for Radiobiology and Radiohygiene, Budapest, Hungary
- 1996-1997: DAAD fellowship owner at HELMHOLZ Centrum, Neuherberg, Germany
- 2000-2007: postdoc and senior scientist at the Dept. of Molecular and Tumour Radiobiology, National Research Institute for Radiobiology and Radiohygiene, Budapest, Hungary
- 2008-2015: department head at the Dept. of Cellular and Immune Radiobiology, National Research Institute for Radiobiology and Radiohygiene, Budapest, Hungary
- 2016- on: department head at the Dept. of Radiation Medicine, National Public Health Centre, Budapest, Hungary

Other professional activities:

- 2017 on: teaching Radiation hygiene at Faculty of Health Sciences, Semmelweis University, Budapest, Hungary

Scientific activities:

Research topics:

- 1993-1997: Investigating oncogenes and tumour suppressor genes in murine tumours induced by in utero irradiation
- 1996-1997: Study of murine lymphomas induced by retrovirus infection
- 1996-1999: Study of cell transformation in p53-deficient murine cell lines as a result of combined retrovirus infection and irradiation
- 2000-2008: Treatment of experimental murine brain tumours with combined immune- and radiotherapy, investigating means of targeted therapies in brain tumours

- 2010 on: study of low dose irradiation effects on the immune system and antitumor immune response
- 2010 on: study of ionizing radiation-induced late side effects
- 2014 on: investigating immune and inflammatory markers in cancer patients treated with radiotherapy
- 2016 on: study the role of extracellular vesicles in mediating ionizing radiation-induced bystander effects

Research grants:

As principal investigator (domestic grants):

- OTKA (2001-2005): Combination of radiotherapy and antiangiogenic therapy in radiosensitized tumour cells for the treatment of experimental murine gliomas (3.86 mFt)
- ETT (2003-2005): Treatment of murine gliomas with hipoxia-specific gene therapy (1.5 mFt)
- OTKA (publ. – 2006): Detailed characterization of the mouse glioma 261 tumour model for experimental glioblastoma therapy (Cancer Science, Blackwell Publishing) (0.095mFt)
- ETT (2006-2008): The effect of combined immune therapy and low dose irradiation on the antitumor immune response (1.988 mFt)
- Hungarian-Romanian bilateral cooperation (2008-2009): Effect of low dose total body irradiation on the immune system (4.43 mFt)
- Hungarian-Italian bilateral cooperation (2012-2014): Risk assessment, development of early biomarkers and analysis of methods able to reduce ionizing radiation-induced side effects (2.22 mFt)
- Hungarian-Romanian bilateral cooperation (2013-2014): Investigating the relevance of cellular and soluble immunological marker in the prognosis of cancer patients (2.6 mFt)
- OTKA (2017-2021) (co-leader next to Géza Sáfrány): Identifying immunological and cytogenetic predictive and prognostic markers in radiotherapy-treated prostate cancer patients (15.964 mFt)

As principal investigator (foreign grants):

- EU FP7 DoReMi-PERIRAD (Low and moderate dose radiation effects on brain microvascular pericytes) 2013-2015 (110000 €)
- EU FP7 DoReMi RadMVivo 2014-2015 (46971 €)
- EU FP7 OPERRA – VIBRATO (Validation in vivo of immune bioindicators of radiation exposure to use for emergency situations, the determination of health effects and molecular epidemiology) 2015-2017 (85000 €)
- Euratom research and training programme 2014-2018 CONCERT – LEU-TRACK (The role of extracellular vesicles in modulating the risk of low dose radiation-induced leukaemia) 2017-2020 (266616 €)

Training of young scientists:

- Partial PhD supervisor for Gergely Huszty (graduated: 2012)
- PhD supervisor for Eszter Persa (graduated: 2018)

- PhD supervisor for Dávid Kis (started his PhD studies in 2018)
- Supervisor for MSc degree for Anna Balogh, Béla Huszák (Health Science Faculty, Semmelweis University, Budapest, Hungary 2019) and Lilla Antal (Eötvös Lóránt University, Budapest, Hungary, 2020)

Other education and training activities:

- responsible for organising radiation protection courses at all levels at the Division of Radiobiology and Radiohygiene, National Public Health Centre
- lectures at various gradual and postgradual courses in the field of radiobiology a different Hungarian universities

Organizing scientific meetings and training courses:

- Low dose radiation effects on the immune system: current knowledge and future research needs – DoReMi workshop, Budapest, Hungary November 5-7, 2013
- Training Course - PCR-based Techniques in Radiobiology and Low-Dose Risk Research, the Integration of New Member States in EURATOM programs, Budapest, Hungary, June 13-17, 2016
- Radiation effects on the immune system: an updated state of the art and future research needs – OPERRA workshop, Budapest, Hungary 7-9 March, 2017
- 44th European Radiation Research Congress, Pécs, Hungary, 21-25 August, 2018 (co-organizer)

Membership in scientific societies:

- European Radiation Research Society (2008-2016: council member)
- MELODI (Multidisciplinary European Low Dose Initiative) (2018 on. member of the executive council)
- Hungarian Biophysical Society – secretary of the Radiobiology section
- Hungarian Immunological Society
- Hungarian Oncological Society
- European Association for Cancer Research
- International Society for Extracellular Vesicles

Other scientific activities:

- reviewer of domestic and international grant applications and scientific manuscripts
- reviewer of doctoral theses

Other activities:

- chair of institutional human ethical committee

Name: Renáta Andrejkovics-Szentmihályi

Education: *public health officer (BSc),* Semmelweis University College of Health Sciences
Nutritionist (MSc), Semmelweis University Faculty of Health Sciences

National Public Health Center
Department: Division of Radiobiology and Radiohygiene
phone number: 00-36-1-482-2000/144
Mobile: 0630-915-6228
E-mail: szentmihalyi.renata@osski.hu
szentmihalyi.renata@nnk.gov.hu

I graduated as a public health officer with BSc degree at Semmeweis University College of Health Sciences. I started to work the Department of children and youth health at the 1st District Institute of National Public and Medical Officer Service. From January 2002 til May 2019 I worked at the National Public Health Institute in the Department of Environmental and Settlement Health. During the years spent there I participated in many environmental epidemiology surveys. These studies were investigated effects of environmental risk factors on human health for both indoor and outdoor environment. Meanwhile between 2012-2014 I attended an MSc course at Semmelweis University, Faculty of Health Sciences where I obtained a qualification as a nutritionist. The theme of my thesis: Association of lifestyle and environmental risk factors with the development of food allergies among 7-11 years old European children. This topic also closely related to my work duties at the time. Currently, from June 2019 I have been working at the National Public Health Center - Division of Radiobiology and Radiohygiene, Department of Radiation Medicine. My responsibilities include organizing radiation protection training as well as the administrative tasks of the department.

Name: Lilla Antal

Education: biologist, ELTE, Budapest

Position: researcher

Department: Division of Radiation Medicine
Phone number: **+ 36-1 / 482-2000 / 127**
E-mail: antal.lilla@osski.hu

antal.lilla@nnk.gov.hu

Address: Hungary, 1221 - Budapest, 5. Anna street „A" building block – Department of Radiation Medicine: Room 26.

I graduated as a biologist with BSc Degree at Eötvös Loránd University in 2015. Currently I study at Budapest University of Technology and Economics - Faculty of Chemical Technology and Biotechnology - Department of Applied Biotechnology and Food Science as an applied biotechnologist master student.

I've been working here since November 2018. I am currently analyzing different methods of isolating EVs from frozen human plasma in order to select the best possible techniques for our research. In addition, my thesis topic is to investigate the effect of ionizing radiation on communication between cells.

Hobbies: hiking, travelling, drawing, playing on drums, playing guitar

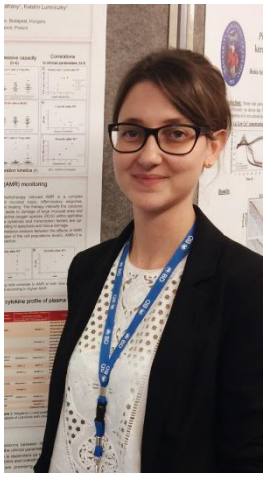
Name: **Katalin Balázs**

Education: biologist, ELTE, Budapest

Position: researcher

Department: Division of Radiation Medicine
Phone number: 00-36-1-482-2000/144
Email: balazs.katalin@osski.hu

balazs.katalin@nnk.gov.hu



I graduated as a biologist, MSc at Biology at Eötvös Lorand University – Department of Immunology in 2018. My thesis is about the migration process of in vitro differentiated macrophages and dendritic cells via CR3 and CR4 complement receptors. My research group wants to develop new migration assays.

I am applied as a biologist at National Public Health Centre – National Research Directorate for Radiobiology and Radiohygiene since July 2016.

Currently I am a PhD student at the Semmelweis University Doctoral School.

My main profile is to examine tumor associated systemic immune suppression. Our aim is to identify cellular and soluble immunological markers, which might have a prognostic value for radiotherapy-response. We collaborate with Maria Sklodowska-Curie Memorial Cancer Center and Institute of Oncology (Gliwice Branch, Poland) and National Institute of Oncology (Budapest, Hungary). Our task is to study not only the phenotypical changes in peripheral blood mononuclear cells but also the protein-profile of plasma samples of head-and-neck and prostate cancer patients.

I also investigate the effect of low dose ionizing radiation on microglia cells in SJL and C57Bl/6 mouse brain.

Name: Ilona Barbara Csordás

Education: public health supervisor student

Department: Division of Radiation Medicine

Phone number: + 36-1 / 482-2000 / 156

E-mail: csordas.ilona@osski.hu

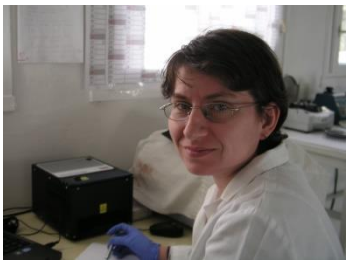
Address: Hungary, 1221 - Budapest, 5. Anna street

My name is Ilona Barbara Csordás, currently I am studying as a public health supervisor at Semmelweis University, Faculty of Health Science. I am studying there since 2016, and I will graduate and get my bachelor degree in this year (2019).

I have studied Radiobiology and Radiohygiene in my 3th year of studies, which was really interesting, and I have decided to write my thesis in this topic at Department of Radiation Medicine, National Public Health Centre. Also I am working here in part-time job since September 2019.

The subject of my thesis is: The study of the biological effects of low dose ionizing radiation. The role of the miRNA in radiation induced bystander effects.

Hobbies: hiking, travelling, reading and yoga



Name: **Rita Hargitai**

Education: biologist, ELTE, Budapest

Position: researcher

Department: Division of Radiation Medicine
Phone number: 00-36-1-482-2000/127
Email: hargitai.rita@osski.hu; hargitai.rita@nnk.gov.hu

I graduated from Eötvös Loránd University with a MSc degree in Biology in 2002, and I obtained a PhD in Biology (Ecology) in 2006. I worked as a senior lecturer at the Institute of Environmental Sciences of the College of Nyíregyháza for 4 years. Between 2012 and 2016, I worked as a post-doctoral research fellow at the Department of Systematic Zoology and Ecology of Eötvös Loránd University, during which time I conducted behavioural ecology studies with songbirds. I have been working at the Department of Radiation Medicine of the Division of Radiobiology and Radiohygiene of the National Public Health Institute as a research fellow since September 2016. The primary aim of my research is to test whether hair samples are suitable biomarkers of low dose, local ionising radiation. I study with qPCR method the lesions and deletions of mitochondrial DNA isolated from mouse and human hair samples

Publications

1) Hargitai, R., Török, J., Tóth, L., Hegyi, G., Rosivall, B., Szigeti, B., Szöllősi E. 2005. Effects of environmental conditions and parental quality on inter- and intraclutch egg-size variation in the Collared Flycatcher (*Ficedula albicollis*). *Auk* 122(2): 509-522.
2) Herényi, M., Török, J., Garamszegi, L.Z., Hargitai, R., Hegyi, G., Michl, G., Rosivall, B., Szigeti, B., Szöllősi, E. 2004. Másodlagos nemi jellegek és utódszám kapcsolata a hím örvös légykapónál. *Állattani közlemények* 89(2): 31-41.
3) Hargitai, R., Matus, Z., Hegyi, G., Michl, G., Tóth, Gy., Török, J. 2006. Antioxidants in the egg yolk of a wild passerine: differences between breeding seasons. *Comparative Biochemistry and Physiology B* 143(2):145-152.
4) Hargitai, R. Prechl, J., Török, J. 2006. Maternal immunoglobulin concentration in Collared Flycatcher (*Ficedula albicollis*) eggs in relation to parental quality and laying order. *Functional Ecology* 20: 829-838.
5) Török, J., Hargitai, R., Hegyi, G., Matus, Z., Michl, G., Péczely, P., Rosivall, B., Tóth, Gy. 2007. Carotenoids in the egg yolks of Collared Flycatchers in relation to parental quality, environmental factors and laying order. *Behavioral Ecology and Sociobiology* 61: 541-550.
6) Szigeti, B., Török, J., Hegyi, G., Rosivall, B., Hargitai, R., Szöllősi, E., Michl, G. 2007. Egg quality and parental ornamentation in the blue tit. *Journal of Avian Biology* 38: 105-112.

7) Hegyi, G., Török, J., Garamszegi, L.Z., Rosivall, B., Szöllősi, E., Hargitai, R. 2007. Dynamics of multiple sexual signals in relation to climatic conditions. *Evolutionary Ecology Research* 9: 905-920.

8) Hegyi, G., Rosivall, B., Szöllősi, E., Hargitai, R., Eens, M., Török, J. 2007. A role for female ornamentation in a facultatively polygynous mating system. *Behavioral Ecology* 18: 1116-1122.
9) Hegyi, G., Rosivall, B., Garamszegi, L.Z., Szöllősi, E., Hargitai, R., Eens, M., Török, J. 2008. Phenotypic plasticity in a female plumage ornament: information content and mating patterns. *Animal Behaviour* 75: 977-989.
10) Hargitai, R., Herényi, M., Török,. J. 2008. Eggshell colouration in relation to female condition, male attractiveness and egg quality in the collared flycatcher (*Ficedula albicollis)*. *Journal of Avian Biology* 39: 413-422.
11) Moskát, Cs., Avilés, J.M., Bán, M., Hargitai, R., Zölei, A. 2008. Experimental support for the use of egg uniformity in parasite egg discrimination by cuckoo hosts. *Behavioural Ecology and Sociobiology* 62: 1885-1890.
12) Moskát, Cs., Hauber, M.E., Avilés, J.M., Bán, M., Hargitai, R., Honza, M. 2009. Increased host tolerance of multiple cuckoo eggs leads to higher fledging success of the brood parasite. *Animal Behaviour* 77: 1281-1290.
13) Avilés, J.M., Moskát, Cs., Bán, M., Hargitai, R., Parejo, D. 2009. Common cuckoos (*Cuculus canorus*) do not rely on indicators of parental abilities when searching for host nests: the importance of host defenses. *Auk* 126 (2): 431-438.
14) Hargitai, R., Arnold, K. E., Herényi, M., Prechl, J., Török, J. 2009. Egg composition in relation to social environment and maternal physiological condition in the collared flycatcher. *Behavioural Ecology and Sociobiology* 63: 869-882.
15) Hargitai, R., Moskát, Cs., Bán, M., Gil, D., López-Rull, I., Solymos, E. 2010. Eggshell characteristics and yolk composition in the common cuckoo *Cuculus canorus*: are they adapted to brood parasitism? *Journal of Avian Biology* 41: 177-185.
16) Hargitai, R., Mateo, R., Török, J. 2011. Shell thickness and pore density in relation to shell colouration, female characteristics, and environmental factors in the collared flycatcher. *Journal of Ornithology* 152: 579-588.
17) Hargitai, R., Hegyi, G., Török, J. 2012. Winter body condition in relation to age, sex and plumage ornamentation in a migratory songbird. *Ibis* 154:410-413.
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19) Herényi, M., Hegyi, G., Garamszegi, L.Z., Hargitai, R., Michl, G., Rosivall, B., Török, J. 2012. Lifetime offspring production in relation to attractiveness, breeding lifespan and mating status in male collared flycatchers. *Oecologia* 170: 935-942.
20) Fekete, I., Kotroczó, Zs., Varga, Cs., Hargitai, R., Townsend, K., Csányi, G., Várbiró, G. 2012. Variability of organic matter inputs affects soil moisture and soil biological parameters in a European detritus manipulation experiment. *Ecosystems* 15:792-803
21) Hargitai, R., Nagy, G., Herényi, M., Török, J. 2013. Effects of experimental calcium availability, egg parameters, and laying order on Great Tit *Parus major* eggshell pigmentation patterns. *Ibis* 155:561-570.
22) Hargitai, R., Hegyi, G, Herényi, M, Laczi, M, Nagy, G, Rosivall, B, Szöllősi, E, Török, J. 2014. Winter body condition in the Collared Flycatcher: Determinants and carryover effects on future breeding parameters. *Auk* 131:257-264.
23) Herényi, M, Garamszegi, LZ, Hargitai, R, Hegyi, G, Rosivall, B, Szöllősi, E, Török, J 2014. Laying date and polygyny as determinants of annual reproductive success in

male collared flycatchers (*Ficedula albicollis*): a long-term study. *Naturwissenschaften* 101:305-312.
24) Hargitai R, Nagy G, Herényi M, Nyiri Z, Laczi M, Hegyi G, Eke Zs, Török J 2016. Darker eggshell spotting indicates lower yolk antioxidant level and poorer female quality in the Great Tit (*Parus major*). *Auk* 133:131-146
25) Hargitai R, Nagy G, Nyiri Z, Bervoets L, Eke Zs, Eens M, Török J 2016. Effects of breeding habitat (woodland versus urban) and metal pollution on the egg characteristics of great tits (*Parus major*). *Science of the Total Environment* 544:31-38.
26) Hargitai R, Nyiri Z, Eke Zs, Török J 2016. Effects of temperature and duration of storage on the stability of antioxidant compounds in egg yolk and plasma. *Physiological and Biochemical Zoology* 89:161-167.
27) Hargitai R, Herényi M, Nagy G, Nyiri Z, Eke Zs, Török J 2016. Effects of environmental conditions on the egg mass, yolk antioxidant level, eggshell thickness and eggshell spotting pattern of Great Tits (*Parus major*). *Journal of Ornithology* 157:995-1006.
28) Hargitai R, Boross N, Nyiri Z, Eke Zs 2016. Biliverdin- and protoporphirin-based eggshell pigmentation in relation to antioxidant supplementation, female characteristics and egg traits in the canary (Serinus canaria). *Behavioral Ecology and Sociobiology* 70: 2093-2110.
29) Hargitai R, Boross N, Hámori S, Neuberger E, Nyiri Z 2017. Eggshell biliverdin and protoporphyrin pigments in a songbird: are they derived from erythrocytes, from blood plasma or from the shell gland? *Physiological and Biochemical Zoology* 90: 613-626.
30) Hargitai R, Boross N, Nyiri Z, Eke Zs 2018. Effects of food limitation on the intensity of blue-green and brown eggshell coloration: an experimental study with the canary. *Journal of Avian Biology* 49:1-12
31) Szatmári T, Persa E, Kis E, Benedek A, Hargitai R, Sáfrány G, Lumniczky K. 2018. Extracellular vesicles mediate low dose ionizing radiation-induced immune and inflammatory responses in the blood. *Int. J. Rad Biol (in press)*

Name: Dávid Kis

Education: medical biotechnologist, PPKE, Budapest

Position: researcher, PhD student

Department: Division of Radiation Medicine
Phone number: + 36-1 / 482-2000 / 150
E-mail: kis.david@osski.hu

Address: Hungary, 1221 - Budapest, 5. Anna street
„A" building block – Department of Radiation Medicine.

I graduated as a biologist with BSc Degree at Eötvös Loránd University in 2016. I completed my master's degree at Pázmány Péter Catholic University Faculty of Information Technology and Bionics as a medical biotechnologist in 2019. I'm currently a PhD student at Semmelweis University Faculty of Pathological Sciences.

I work from 2015 as a researcher. My main research topic is focused on the study of extracellular vesicles biology. We investigate the role of ionizing radiation on EV kinetics and cargo and the potential role of EVs to mediate radiation-induced bystander responses. Recently we have started investigating the role of EVs in radiation-induced leukemogenesis.

Within this new project, I will be responsible for extracellular vesicles (EVs) isolation and the phenotyping of bone- and bone marrow cells.

During my work I got familiar with various DNA and EV isolation techniques, PCR and real-time qPCR, immunostaining and basics of flow cytometry, evaluating experimental results and demanding presentation.

Posy: The FLOW must go on.

Hobbies: hiking, skiing, travelling.

Pub.:

Tünde Szatmári, **Dávid Kis**, Enikő Noémi Bogdándi, Anett Benedek, Scott Bright, Deborah Bowler, Eszter Persa, Enikő Kis, Andrea Balogh, Lívia N. Naszályi, Munira Kadhim, Géza Sáfrány and Katalin Lumniczky; Extracellular Vesicles Mediate Radiation-Induced Systemic Bystander Signals in the Bone Marrow and Spleen; (2017); Frontiers in Immunology; doi.org/10.3389/fimmu.2017.00347;

Name: **Enikő Kis**
Education: biologist, UBB, Cluj-Napoca
Position: researcher
Department: Division of Radiation Medicine
Phone number: 00-36-1-482-2000/144
Email: kise@osski.hu
kis.eniko@nnk.gov.hu

Member of Scientific Societies:

- Hungarian Biophysical Society
- European Radiation Research Society
- Hungarian Cancer Society

Research interest:
I work for the Insitute since 2002 as a biologist. My research fields are the study of cytological and genetic background of human radiation sensitivity in search for a radiation sensitivity marker and radiation response genes in human cells, normal and tumor samples. I also study blood plasma protein content alterations caused by ionozing radiation in both human and mouse model. Lately I begun to study genetic alterations (deletions and translocations) that cause radiogene leukemia on a mouse model.
As a member of the Institute's radiation biodosimetry group, amongst my duties are dose estiamation from human blood samples and participation in the work of international networks built for mass radiation casualty emergency management.

Name: **Eszter Persa**
Education:
biologist MSc, ELTE, Budapest
PhD degree, Semmelweis University, Budapest
Position: researcher
Department: Division of Radiation Medicine
Phone number: 00-36-1-482-2000/127

E-mail: persa.eszter@osski.hu, persa.eszter@nnk.gov.hu

I graduated in Eötvös Loránd University Faculty of Science as a biologist in 2008. I work in the research group of dr. Katalin Lumniczky since 2009. My topic was study the effect of low dose irradiation on spleen lymphocytes in mice, particularly on dendritic cells and regulatory T cells. I became familiar with animal works, flow cytometry and aspetic cell culture methods. After my maternity leave I joined to the groups's research on extracellular vesicles as potencial mediator of radiation-induced bystander effects. . In 2018 I finished my PhD studies in Pathology Doctoral School at Semmelweis University. My PhD thesis was „The effect of ionizing radiation on immune system".

I enjoy my free time with my children and I love baking cakes – for my collegues, as well.

Publications:

Szatmári T*, Persa E*, Kis E, Benedek A, Hargitai R, Sáfrány G, Lumniczky K. Extracellular vesicles mediate low dose ionizing radiation-induced immune and inflammatory responses in the blood. Int J Radiat Biol. 2019 Jan;95(1):12-22.

Persa E, Szatmári T, Sáfrány G, Lumniczky K. In Vivo Irradiation of Mice Induces Activation of Dendritic Cells. Int J Mol Sci. 2018 Aug 14;19(8).

Szatmári T, Kis D, Bogdándi EN, Benedek A, Bright S, Bowler D, Persa E, Kis E, Balogh A, Naszályi LN, Kadhim M, Sáfrány G, Lumniczky K. Extracellular vesicles mediate radiation-induced systemic bystander signals in the bone marrow and spleen. Front Immunol. 2017 Mar;8:347.

Persa E, Balogh A, Sáfrány G, Lumniczky K. The effect of ionizing radiation on regulatory T cells in health and disease. Cancer Lett. 2015 Nov 28;368(2):252-61.

Klausz B, Kis A, Persa E, Miklósi A, Gácsi M. A quick assessment tool for human-directed aggression in pet dogs. Aggress Behav. 2014 Mar-Apr;40(2):178-88.

Kis A, Klausz B, Persa E, Miklósi Á, Gácsi M. Timing and presence of an attachment person affect sensitivity of aggression tests in shelter dogs. Vet Rec. 2014 Feb 22;174(8):196.

Balogh A*, Persa E*, Bogdándi EN, Benedek A, Hegyesi H, Sáfrány G, Lumniczky K. The effect of ionizing radiation on the homeostasis and functional integrity of murine splenic regulatory T cells. Inflamm Res. 2013 Feb;62(2):201-12.

Bogdándi EN, Balogh A, Felgyinszki N, Szatmári T, Persa E, Hildebrandt G, Sáfrány G, Lumniczky K.. Effects of low-dose radiation on the immune system of mice after total-body irradiation. Radiat Res. 2010 Oct;174(4):480-9.

* shared first authorship

Name: **Nikolett Sándor**
Education: chemist, ELTE, Budapest
Position: researcher
Department: Division of Radiation Medicine
Phone number: **+ 36-1 / 482-2000 / 156**
E-mail: sandor.nikolett@osski.hu
sandor.nikolett@nnk.gov.hu

Membership of scientific society:
- The European Radiation Research Society (ERRS),
- Hungarian Biophysical Society

I graduated the Faculty of Chemistry and Environmental sciences from ELTE in 2007. I have been working for NRIRR since 2008. The main part of my work is to measure the cellular or organism response to the ionizing radiation in human cell culture or mouse models. In previous projects I studied the changes in the expression of radioresponse genes in vitro, I participate in bystander effect measurements and genetic instability experiments, furthermore in the mapping of the blood-brain barrier damages after local head irradiation, or scanning molecular changes after local heart beam in mice in vitro and in vivo.
In my present work I study the development of acute myeloid leukemia caused by ionizing radiation, especially the contribution of extracellular vesicles to these processes.
From 2012 I am a student of the Ph.D. School of Pathology at Semmelweis University, my doctoral dissertation is about genes that are involved in individual radiation responses.
From 2018 I work in biodosimetry also.

My hobbies include ballroom dancing and singing.

Publications:

- **Scientific papers:**

1. **Analysis of the common deletions in the mitochondrial DNA is a sensitive biomarker detecting direct and non-targeted cellular effects of low dose ionizing radiation**
Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis
Volume 716, Issues 1-2, 1 November 2011, Pages 33-39.
(Boglárka Schilling-Tóth, Nikolett Sándor, Enikő Kis, Munira Kadhim, Géza Sáfrány, Hargita Hegyesi) http://www.ncbi.nlm.nih.gov/pubmed/21843534

2. **Role of GDF15 in radiosensitivity of breast cancer cells.**
Boglárka Schilling-Tóth, Nikolett Sándor, Fruzsina R. Walter, Alexandra Bocsik, Géza Sáfrány, Hargita Hegyesi
Central European Journal of Biology
Cent. Eur. J. Biol. 9(10), 2014. p.982-992, DOI: 10.2478/s11535-014-0328-8-8
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3. **Low Dose Cranial Irradiation-Induced Cerebrovascular Damage Is Reversible in Mice.**
Nikolett Sándor, Fruzsina R. Walter, Alexandra Bocsik, Petra Sántha, Boglárka Schilling-Tóth, Violetta Léner, Zoltán Varga, Zsuzsanna Kahán, Mária A. Deli, Géza Sáfrány, Hargita Hegyesi, PLOS ONE, Published: November 13, 2014 DOI: 10.1371/journal.pone.0112397
http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0112397

4. **Growth Differentiation Factor-15 (GDF-15) is a potential marker of radiation response and radiation sensitivity**.

Nikolett Sándor, Boglárka Schilling-Tóth, Enikő Kis, Anett Benedek, Katalin Lumniczky, Géza Sáfrány,Hargita Hegyesi, Mutat Res Genet Toxicol Environ Mutagen. 2015 Nov;793: 142-149. doi: 10.1016/j.mrgentox.2015.06.009.
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5. TP53inp1 Gene Is Implicated in Early Radiation Response in Human Fibroblast Cells.
Sándor N, Schilling-Tóth B, Kis E, Fodor L, Mucsányi F, Sáfrány G, Hegyesi H., Int J Mol Sci, 2015 Oct 23;16(10):25450-65. doi: 10.3390/ijms161025450.
http://www.ncbi.nlm.nih.gov/pubmed/26512655

- **Book chapters:**

1. **Validation of Growth Differentiation Factor (GDF-15) as a Radiation Response Gene and Radiosensitizing Target in Mammary Adenocarcinoma Model.**
Hargita Hegyesi, James R. Lambert, Nikolett Sándor, Boglárka Scilling-Tóth and Géza Sáfrány
Susan J. Done (eds.), Breast Cancer - Recent Advances in Biology, Imaging and Therapeutics
ISBN 978-953-307-730-7 Published by InTech. 2011 (Chapter 20.)
http://cdn.intechweb.org/pdfs/24965.pdf

2. **Differentially expressed genes associated with low-dose gamma radiation Growth Differentiation Factor (GDF-15) as a radiation response gene and radiosensitizing target.**
Hargita Hegyesi, Nikolett Sándor, Boglárka Schilling, Enikő Kis, Katalin Lumniczky, and Géza Sáfrány.
Garcia and M.C. Fuss (eds.), Radiation Damage in Biomolecular Systems, Biological and Medical Physics, Biomedical Engineering,
DOI 10.1007/978-94-007-2564-5 21, Published by Springer Science+Business Media B.V. 2012 (Chapter 21.)
http://www.springerlink.com/content/kt8110257321w46u/

Name: **Tünde Szatmári**
Education: biologist, BBTE, Kolozsvár, Romania
PhD: Semmelweis University, Budapest, Hungary
Position: researcher
National Public Health Center
Division of Radiobiology and Radiohygiene
Phone number: 00-36-1-482-2000/150
Email: szatmari.tunde@osski.hu
szatmari.tunde@nnk.gov.hu

I graduated from Babes-Bolyai University from Kolozsvár (Cluj) with a MSc degree in Biology and Ecology in 1998. Between 1999-2002 I worked as a biologist at the Babes-Bolyai University of Cluj-Napoca. From 2002 to 2009 I worked at the National Research Institute for Radiobiology and Radiohygiene (NRIRR) Budapest, Department of Molecular and Tumor Radiobiology. Meantime I obtained my PhD degree at the Semmelweis Medical University, Budapest (2009). The title of my thesis was „Improving the Radiosensitivity of Brain Tumors by Gene-directed Enzyme Prodrug Therapy". From 2010 to 2015 I worked as a post-doctoral fellow at Karolinska Institutet, Sweden, Dept. of Laboratory Medicine, Division of Pathology, where I studied the differentiation and molecular signature of malignant tumors of the lung and pleura, with special emphasis on the role of syndecan-1 in these processes. In 2015 I returned to the NRIRR, now the Division of Radiobiology and Radiohygiene of the National Public Health Institute/National Public Health Center and presently I work here as a researcher. In my current research I am focusing on the study of the role of extracellular vesicles in the mediation of ionizing radiation induced signals, particularly flow cytometric analysis of extracellular vesicles and study of the miRNA cargo of these vesicles.

PUBLICATIONS:

1. **Szatmári T**, Persa E, Kis E, Benedek A, Hargitai R, Sáfrány G, Lumniczky K. Extracellular vesicles mediate low dose ionizing radiation-induced immune and inflammatory responses in the blood.Int J Radiat Biol. 2018 Mar 13:1-31. doi: 10.1080/09553002.2018.1450533. [Epub ahead of print]
2. **Szatmári T,** Mundt F, Kumar-Singh A, Möbus L, Ötvös R, Hjerpe A, Dobra K. Molecular targets and signaling pathways regulated by nuclear translocation of syndecan-1. BMC Cell Biol. 2017 Dec 8;18(1):34. doi: 10.1186/s12860-017-0150-z.
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