International Sakharov Environmental University

TEMPUS

HUMAN Security
(environment, quality of food, public health and society) on Territories Contaminated by Radioactive Agents
530644-TEMPUS-1-2012-1-FS-TEMPUS-JPCR

Masters training on speciality

1-33 81 02 “Radiobiology”

2013

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This edition contains the information about Masters Degree Programme on speciality 1-33 81 02 "Radiobiology" which has been developed in the framework of the project 530644-TEMPUS-1-2012-1-ES-TEMPUS-JPCR "HUMAN security (environment, quality of food, public health and society) on Territories Contaminated by Radioactive Agents" by academic staff o ISEU.

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Masters Training on speciality 1-33 81 02 "Radiobiology" - International Sakharov Environmental University, 2013 - 40 p.

Content

Introduction

The central mission of the International Sakharov Environmental University (ISEU), founded in 1992, is the development of environmental sciences through integration of academic knowledge and practical skills and opening new viewpoints and perspectives to both education and economy. The university has been successful in implementing its mission. Now its reputation is well established in Belarus and beyond.

Today the University includes two main Faculties: “Environmental Monitoring and Management” and “Environmental Medicine”. These faculties train specialists in the fields of Radioecology, Environmental monitoring, management and audit, Environmental information systems, Radiobiology, Radiation medicine and Biomedicine.

Multifunctional training of the graduates of the ISEU allows to analyze the state of the environmental and ecological information at the high level as well as to use various hardware and software tools of information science, methods of mathematical simulation, analysis and forecast of the state of natural objects for solving professional problems. In accordance with the international status of the university its students get profound knowledge in English and another foreign language (they may choose from German, Spanish and French), that lets them communicate with the specialists of other countries in a professional way.

The University has two stage of educational: Bachelor and Master Degree to specialties as “Ecology. Biological science” and “Ecology. Technical science” and also Ph.D. education.

In 2013-2014 a new speciality of “Radiobyology” which had been developed in the framework of the project 530644-TEMPUS-1-2012-1-ES-TEMPUS-JPCR “HUMAN security (environment, quality of food, public health and society) on Territories Contaminated by Radioactive Agents” is being planned to be started.

This edition consists of the Curriculum of Masters training, Comparison of curricula for Master speciality "Ecology. Biological science" and (2010) and speciality "Radiobiology" (2013) and Syllabuses of subjects.

Welcome to the ISEU!

AUTHORIZED
Vice-rector for Academic Work of ISEU
_____A.I. Rodzkin
«___»_____2013 г.

CURRICULUM of Masters training
Speciality: 1-33 81 02 "Radiobiology"
Educational-qualification level: Master
Qualification: Master of radiobiology
The period of training after getting Bachelor's – 1 year and 6 month
The form of training - Full-time

I. The Schedule of training

Weeks	Month	Type of activity	Academic work		
			Total hours	Auditoria hours	Self-study work
1-19	September-January	Academic work and research work	1026	242	784
20-22	January	Testing	162		162
23-24	February	Holiday			
25-43	February-June	Academic work and research work	1026	266	760
44-46	July	Testing	162		162
47-52	June- August	Holiday			
53-58	September-October	Academic work and research work	324	72	252
59-60	October- November	Testing	108		108
61-66	November-December	Practice	324		324
67-72	December- January	Theses preparation and defense	324		324
		Total:	**3456**	**580**	**2876**

II. Curriculum

№	Cycles of disciplines and Name of the subject	Semester control		Hours			Semester /Weeks								
							1 semester / 19 weeks			2 semester / 19 weeks			3 semester / 6 weeks		
		Exams	Credit	Total	Classroom hours	Self-study work	Classroom hours	Self-study work	Nr. of ECTS Credits	Classroom hours	Self-study work	Nr. of ECTS Credits	Classroom hours	Self-study work	Nr. of ECTS Credits
1.	**Special disciplines**			**1576**	**580**	**996**	**242**	**418**	**17**	**266**	**434**	**18,5**	**72**	**144**	**6**
1.1	***State block***			*748*	*236*	*512*	*100*	*220*	*9*	*100*	*220*	*9*	*36*	*72*	*3*
1.1.1	Radioactivity & Ecosystems	1		160	50	110	50	110	4,5						
1.1.2	Molecular and cellular radiobiology	1		160	50	110	50	110	4,5						
1.1.3	Radiation detection and control	2		160	50	110				50	110	4,5			
1.1.4	Radioecologycal monitoring and analysis	2		160	50	110				50	110	4,5			
1.1.5	Legislative aspects of human security on radionuclide polluted areas	3		108	36	72							36	72	3
1.2	***Training courses selected by the University***	*1,2,3*	*1,2*	*652*	*256*	*396*	*104*	*160*	*6*	*116*	*164*	*7*	*36*	*72*	*3*
1.2.1.	Radiation Biochemistry		2	120	58	62				58	62	3			
1.2.2	Radiotoxicology and Risk Assessment		1	104	52	52	52	52	2,5						
1.2.3	Psychological rehabilitation	2		160	58	102				58	102	4			
1.2.4	Medical and environmental rehabilitation	1,3		268	88	180	52	108	4				36	72	3

1.3	***Training courses selected by the student***		*1,2*	*176*	*88*	*88*	*38*	*38*	*2*	*50*	*50*	*2,5*			
1.3.1	Data Analysis and GIS In Radiobiology /Sustainable development		1	76	38	38	38	38	2						
1.3.2	English for academic purpose / Methods of scientific research		2	100	50	50				50	50	2,5			
2.	**Research work**		1,2,3	**1232**		**1232**		**528**	**13**		**488**	**11,5**		**216**	**6**
3.	**Practice**			**324**		**324**								**324**	**9**
4.	**Theses preparation and defense**			**324**		**324**								**324**	**9**
	Total			**3456**	**580**	**2876**	**342**	**846**	**30**	**342**	**846**	**30**	**342**	**846**	**30**

Dean of the Faculty of Environmental Medicine _____ I.E. Buchenkov

Head of the Chair of Environmental Medicine and Radiobiology _____ V.D. Svirid

Head of the Academic and methodical Department _____ T.A. Akinsheva

Comparison of curricula for Master speciality 1-33 80 01 "Ecology. Biological science" and (2010) and speciality 1-33 81 02 "Radiobiology" (2013)

Master speciality	**Ecology. Biological science**		**Radiobiology**	
The year from which the programme has been launched	2010		2013	
Language	Russian		English	
Years/Semesters	1 / 2	**ECTS Credit**	1,5/ 3	**ECTS Credit**
Special disciplines	Philosophy and methodology of science	-	Radioactivity & Ecosystems	4,5
	Foreign language	-	Molecular and cellular radiobiology	4,5
	The basis of informational technology	-	Radiation detection and control	4,5
	Pedagogy and psychology of high school	-	RadioEnvironmental Monitoring and Analysis	4,5
	The mechanisms of environmental factors impact on alive systems	-	Legislative aspects of human security on radionuclide polluted areas	3
Training courses selected by the University	The mechanisms of environmental factors influence on the living systems of various levels of organization	-	Radiation Biochemistry	3
	The mechanisms of physiological adaptation of the organism	-	Radiotoxicology and Risk Assessment	2,5
	-	-	Psychological rehabilitation	4
	-	-	Medical and environmental rehabilitation	7
Training courses selected by the student	-	-	Data Analysis and GIS in Radiobiology / Sustainable development	2
	-	-	English for academic purpose / Methods of scientific research	2,5
Academic work (hours)				
Research work	684		1 232	
Practice	108		324	
Auditoria hours	528		580	
Self-study work	678		996	
Theses preparation and defense	270		324	
Total hours	2 268		3 456	

Realization of the interdisciplinary approach

- The discipline “Legislative aspects of human security on radionuclide polluted areas” inputs of WP 4 Belarusian States University (BSU) for ISEU
- The discipline “Sustainable development” (has been introduced in the) / inputs from WP 2 (ISEU) for BSU

Syllabuses of subjects

RADIOACTIVITY & ECOSYSTEM

Author: Nadezhda V. Goncharova, Professor, Ph.D. (Biological Science, plant physiology)
Total hours: 160
Lectures - 30
Seminars – 20
Self-study work - 110

Form of control: exam
Nr. of ECTS Credits: 4,5
Semester: 1
Course Level – 1st year MA

Goals of the course:
- understanding global atmospheric circulation and biogeochemical cycles in general, as a result of the study of transfer of radionuclides, which acted as tracers;
- learn the mechanisms dispersion and transfer radionuclides between environmental compartments and along food chains and food webs;
- give bases to understand the effects of ionizing radiation on most non-human species and whole ecosystems.

Learning outcomes of the course:
Professional/disciplinary skills:
- use knowledge about the effect of ionizing radiation on micro- organisms, plants and animals as well as on natural and semi-naturals ecosystems;
- know the problems of natural and man-made radioactivity in the environment in terms of transfer and effects on biota, whereas radiobiology is essentialy concerned with effects on humans.

Personal skills:
- the ability to communicate complex scientific ideas, the conclusions of an experiment, investigation or project concisely, accurately and informatively;
- the ability to manage their own learning and to make use of appropriate texts, research articles and other primary sources;
- responsibility for personal and professional development. Ability to use external mentors for personal / professional purposes.

Short Contents:
1. Historical perspectives; introduction to radioactivity and to ecology.
2. Sources of ionizing radiation in the environment.
3. Critical analysis of how non-ionizing radiation propagates and its interaction with tissue
4. Critical analysis of the biological basis for setting standards for human exposure to electromagnetic fields and radiation.
5. Radioactive particle releases: Air/water transport of particles will differ from that of aerosols/ions.
6. Dispersion and transfer in the terrestrial environment.
7. Dispersion and transfer in the aquatic environment.
8. Effects of ionizing radiation on aquatic and terrestrial organisms.
9. Effects of ionizing radiation on ecosystems.
10. Assessing the radiological impact of releases to the environment.
11. Management of radioactive releases to the environment.
12. Accidental releases and countermeasures.
13. Human and Ecological Risks from Radioactive Contaminants
14. Radioactivity in the marine environment

15. Multiple stressors: Ionizing radiation, UV and other chemical stressors act by either same modes of action or different modes of action or at different sites. Combined responses will deviate from simple dose or concentration assessments and might give additive, synergistic or antagonistic effects.

Themes of seminars:

1. The accidents at Chernobyl and Fukushima, comparison of accidents.
2. Radon in the human environment: Physics of radon decay; Radon metrology, Radon dosimetry.
3. Nuclear terrorism.
4. Introduction to Radioecology: environmental risk assessment.
5. Sources of radioactivity in the environment.
6. Modelling the transfer of radionuclides into foodstuffs.
7. Factors impacting on the ecosystem transfer of radionuclides.
8. Dose commitment from incorporated radionuclides in medicine and from environmental contamination.
9. Use of isotope techniques in environmental chemistry.
10. Modelling atmospheric dispersion and deposition of radionuclides after Nuclear accidents

Readings:

1. Bugai D., Kashparov V., Dewiére L., Khomutinin Yu., Levchuk S., Yoschenko V. Characterization of subsurface geometry and radioactivity distribution in the trench containing Chernobyl clean-up wastes //Environmental Geology, v.47, 2005, p.869-881.
2. Colle C., Kashparov V., Zvarich S., Yoschenko V., Levchuk S., Lundin S. Fate of long-lived radioactive halogens, (36Cl, 129I), in agricultural ecosystems: Field investigations, Radioprotection v. 40 No. Suppl. 1 (May 2005), p. S329-S334.
3. Dewiere L., Bugai D., Grenier C., Kashparov V., Ahamdach N. 90Sr migration to the geo-sphere from a waste burial in the Chernobyl exclusion zone //Journal of Environmental Radioactivity, v.74, Issue 1-3, 2004, p.139-150.
4. Dewiere L., Bugai D., Kashparov V., Barthès V. Validation of the global model for 90Sr migration from the waste burial in the Chernobyl exclusion zone, Radioprotection v. 40 No. Suppl. 1 (May 2005), p. S245-S251.
5. Environmental consequences of the Chernobyl accident and their remediation: twenty years of experience //Report of the Chernobyl Forum Expert Group 'Environment', Ed. Anspaugh, L. and Balonov, M., Radiological assessment reports series, IAEA, STI/PUB/1239, 2006, 166p.
6. Fesenko S. V., Alexakhin R. M., Balonov M. I., Bogdevich I. M.,Howard B. J., Kashparov V. A., Sanzharova N. I., Panov A. V., Voigt G., Zhuchenka Yu. M. Twenty years' application of agricultural countermeasures following the Chernobyl accident: lessons learned //Journal of Radiological Protections, v. 26, 2006, p.351–359.
7. Fesenko S.V., Alexakhin R.M., Balonov M.I., Bogdevich I.M, Howard B.J., Kashparov V.A., Sanzharova N.I., Voigt G, Zhuchenko Yu. Consequences for agriculture //Nuclear engineering international, March 2006, p.34-37.
8. Fesenko S.V., Alexakhin R.M., Balonov M.I., Bogdevitch I.M., Howard B.J., Kashparov V.A., Sanzharova N.I., Panov A.V., Voigt G., Zhuchenka Y.M An extended critical review of twenty years of countermeasures used in agriculture after the Chernobyl accident // Science of The Total Environment, 2007, v. 383 (1), pp. 1-24.
9. Frank G., Kashparov V., Protsak V., Tschiersch J. Comparison measurements of a Russian standard aerosol impactor with several western standard aerosol instruments //J. of Aerosol Science, Vol.27, N. 3, 1996, p.477-486.
10. Gludkov, A. N. Kashparov V. A., Kolobashkin V. M., Kotlyarov A. A., Kurepin A. D., Ponomarev-Stepnoi N. N. and Khrulev A. A. Method for obtaining samples for measuring the distribution of nuclear fuel and its fission products in HTR fuel particles // Atomic Energy, Volume 66, Number 3, pp.211-213.
11. Handbook of parameter values for the prediction of radionuclide transfer in terrestrial and fresh-water environments. Vienna: IAEA-TRS-472, 2010.

12. Ivanov Y.A., Kashparov V.A. Long-Term Dynamics of the Radioecological Situation in Terrestrial Chernobyl Exclusion Zone //Environmental Science and Pollution Research, v.10 Special (1), 2003, pp.13-20.
13. Jacob P., Fesenko S., Bogdevitch I., Kashparov V., Sanzharova N., Grebenshikova N., Isamov N., Lazarev N., Panov A., Ulanovsky A., Zhuchenk Y., Zhurba M. Rural areas affected by the Chernobyl accident: Radiation exposure and remediation strategies //Science of The Total Environment, v. 408, Issue 1, 2009, p. 14-25.
14. Kashparov V. Assessment of the radiological situation resulted by the accidental release of fuel particles //Radioprotection – Colloques, v.37, 2002-C1 pp.1061-1066.
15. Kashparov V., Ahamdach N., Levchuk S., Yoschenko V., Fesenko S., Maloshtan I. Dissolution of particles of irradiated nuclear fuel in the temporary storages of radioactive waste in Chernobyl zone: sources for radionuclides migration //Radioactive Particles in the Environment, NATO Science for Peace and Security Series C: Environmental Security, ed. by D.Oughton, V. Kashparov, Published by Springer, the Netherlands 2009, p. 139-156.
16. Kashparov V., Colle C., Levchuk S., Yoschenko V., Svydynuk N. Transfer of chlorine from the environment to agricultural foodstuffs //Journal of Environmental Radioactivity, v.94, Issue 1, 2007, p.1-15.
17. Kashparov V., Colle C., Levchuk S., Yoschenko V., Zvarich S. Radiochlorine concentration ratios for agricultural plants in various soil conditions //Journal of Environmental Radioactivity, v. 95, Issue 1, 2007, p.10-22.
18. Kashparov V., Colle C., Zvarich S., Yoschenko V., Levchuk S., Lundin S. Soil-to-plant halogens transfer studies 1. Root uptake of radioiodine by plants //Journal of Environmental Radioactivity, v.79, Issue 2, 2005, p.187-204.
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21. Kashparov V.A. Assessment of ecological risk caused by the long-living radionu-clides in environment // Ecotoxicology, ecological risk assessment and multiple stressors, NATO Security though Science series – C: Environmental Security, ed. by G. Arapis, Published by Springer, the Netherlands, vol.6, 2006, p.155-164.
22. Kashparov V.A. Hot Particles at Chernobyl //Environmental Science and Pollution Research, v.10 Special (1), 2003, pp.21-30.
23. Quantification of radionuclide transfer in terrestrial and freshwater environments for radiological assessments, IAEA-TECDOC-1616, Vienna, 2009, p. 616.
24. Radioecology Radioactivity&Ecosystems. Van der Stricht & Kirchmann, Editors, June 2001. 624 pages ISBN 2-9600316-0-1
25. Salbu B., Krekling T., Lind D.H., Oughton D.H., Drakopoulas M., Simionovichi A., Snigireva I., Snigirev A., Weitkamp T., Adams F., Janssens K., Kashparov V. High energy X-ray microscopy for characterization of fuel particles // Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volumes 467-468, Part 2, 21 July 2001, p.1249-1252.
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27. Sandalls J., Ivanov Y., Kashparov V., Arkhipov N. Fuel Particles Still Dominate the Chernobyl Scene //Radioactive Waste Management and Environmental Restoration, vol.20, 1997, p.237-247.

28. Shestopalov V.M., Kashparov V.A., Ivanov Y.A. Radionuclide Migration into the Geological Environment and Biota Accident //Environmental Science and Pollution Research, v.10 Special (1), 2003, pp.39-47.
29. Thiry Y., Colle C., Yoschenko V., Levchuk S., Van Hees M., Hurtevent P., Kashparov V. Impact of Scots pine (Pinus sylvestris L.) plantings on long term 137Cs and 90Sr recycling from a waste burial site in the Chernobyl red Forest //Journal of Environmental radioactivity, v.100, Issue 12, 2009, p.1062-1068.
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34. Yoschenko V.I., Kashparov V.A., Levchuk S.E., Glukhovskiy A.S., Khomutinin Yu.V., Protsak V.P., Lundin S.M. and Tschiersch J. Resuspension and redistribution of radionuclides during grassland and forest fires in the Chernobyl exclusion zone: part II. Modeling the transport process //Journal of Environmental Radioactivity, v.87, Issue 3, 2006, p. 260-278.
35. Yoschenko V.I., Kashparov V.A., Protsak V.P., Lundin S.M., Levchuk S.E., Kadygrib A.M., Zvarich S.I., Khomutinin Yu.V., Maloshtan I.M., Lanshin V.P., Kovtun M.V., Tschiersch J. Resuspension and redistribution of radionuclides during grassland and forest fires in the Chernobyl exclusion zone: part I. Fire experiments //Journal of Environmental Radioactivity, v.86, Issue 2, 2006, p.143-163.
36. Yoschenko V.I., Kashparov V.A., Protsak V.P., Tschiersch J. Autoradiographical methods for the assessment of radionuclides in hot particles on the filter samples //Applied Radiation and Isotopes, v.58, 2003, p.95-102.
37. Zhurba M., Kashparov V., Ahamdach N., Salbu B., Yoschenko V., Levchuk S. The “hot particles” data base //Radioactive Particles in the Environment, NATO Science for Peace and Security Series C: Environmental Security, ed. by D.Oughton, V. Kashparov, Published by Springer, the Netherlands 2009, p. 187-195.

MOLECULAR AND CELLULAR RADIOBIOLOGY

Author: Irina V. Puhteeva, Senior Lecturer.
Total hours: 160
Lectures - 28
Laboratory classes - 12
Practical lessons – 10
Self-study work - 110

Form of control: exam
Nr. of ECTS Credits: 4,5
Semester: 1
Course Level: 1st year MA

Goals of the course
- formation of modern scientific knowledge and understanding of the effects of ionizing radiation at the molecular and cellular levels.
- give knowledge about of the damage caused by ionizing and non-ionizing radiation in cells.
- study the molecular mechanisms behind critical cellular responses to ionizing radiation (including DNA repair, cellular proliferation and inflammation), as well as to develop biological markers that predict how an individual may respond.
- learn the mechanisms regulating the biological process by ionizing irradiation in low and high doses.
- give bases to understand the effect of radiations on the cell.

Learning outcomes of the:
Professional/disciplinary skills: in laboratory experience, in the health care system, in the research, in the education activity.
Personal skills: use that knowledge to the analysis of structural and functional changes in the body due to radiation; use the received theoretical knowledge in independent professional activities.

Short content:

1. Physics and Chemistry of radiation interaction with matter. Interactions of electromagnetic radiations with matter. Interactions of particles with matter. Linear energy transfer (LET)/Relative biologic effectiveness (RBE). Direct/Indirect effects of radiation on macromolecules.

2. Theoretical fundamentals of radiobiology. Qualitative and quantitative trends in radiobiology. The principle of hitting and targets. Stochastic hypothesis. Probabilistic model of radiation damage cells. The hypothesis of primary radiation toxins. Structural-metabolic theory.

3. Radiobiological definition of cell death and cell survival. Types of radiation lesions to DNA and it repair. Effects on chromosomes – use in biodosimetry. Manifestations of radiation-induced cell death. Survival curves and models, clonogenicity, limitations of determination of cell numbers at a fixed time. RBE – cell survival – change in slope and shoulder of survival curve, dependence of RBE on dose. Cellular repair: sub lethal damage repair (SLDR)/potential lethal damage repair (PLDR) cell survival, half time of repair. Dose rate effects: dependence on repair and proliferation.

Radiobiological effects on the developing embryo. Intrauterine death, congenital malformations, and neonatal death, microcephaly, severe mental retardation, growth retardation. Dependence on gestational age of radiation effects on the embryo or foetus. Protection of the embryo in diagnostic radiology and from occupational exposure.

4. Cell survival curves. Colony formation assays versus cell viability assays. Dose-survival relationships. Linear-quadratic model; two component exponential model, definition of survival curve parameters. Sub-lethal and potentially lethal damage repair, half time of repair and

incomplete repair, effect of unequal fraction size on repair. Dose rate and fractionation effects. Oxygen effect – level, time scale, mechanisms. LET versus OER and RBE. Radio-sensitizers, protectors.

5. Radiobiology of Normal Tissue damage. Early and late normal tissue damage. Growth factors and stimulated regeneration (including stem cells). Concept of normal tissue tolerance.

6. Cell cycle description. Methods to determine cell cycle parameters. Control of cell cycle: cyclins, cyclin dependent kinases (CDKs), cyclin dependent kinase inhibitors (CDKIs), role of p53. Sensitivities in different phases of cell cycle and cell cycle checkpoints. Radiation-induced cell cycle checkpoints.

7. Cell death mechanisms. Radiobiological definition of cell death, abortive cell divisions after irradiation. Apoptosis. Necrosis. Mitotic Catastrophe.

8. DNA damage and repair. Types of lesions and frequency per cell per Gy. Multiple damaged sites (clustered damage). Types and Molecular mechanisms of DNA repair: base damage, single strand breaks, double-strand breaks, repair of cross-links, mutations affecting repair (ATM etc), molecular responses to DNA damage (p53, ATM, etc).

9. Other molecular targets. Membranes (Oxidative damage, lipid peroxidation). Activation of stress response genes, radiation induced signal transduction. Cell signalling – signalling cascades. Receptor/ligand interactions; phosphorylation/dephosphorylation reactions. Radiation effects on cell signalling, e.g. EGFR pathway.

10. Non-target effects in radiobiology. Low dose hypersensitivity, induced radio-resistance, mechanisms. Bystander effects, mechanisms.

Themes of seminars:

1. Physics and Chemistry of radiation interaction with matter.
2. Cell survival curves.
3. Cell cycle description.
4. Cell death mechanisms. DNA damage and repair.
5. Non-target effects in radiobiology.

Themes of laboratory classes:

1. Genetic and cytogenetic effects of exposure to ionizing radiation.
2. Building a survival curves and their basic parameters.
3. Methods of estimation of the functional state of immune cells after radiation exposure.

Readings:

1. INTERNATIONAL COMMISSION OF RADIATION PROTECTION Publication 103: 2007 recommendations of the ICRP, including Annexes on Quantities used in radiation protection, Biological effects of radiation, and Bases for judging the significance of the effects of radiation. Ann ICRP 37: issues 2-4, 1-332, 2008.
2. Gent V., hoeijmakers D.C., Kanaar J.H. Chromosomal stability and the DNA double-stranded break connection, Nat. Rev. Genet1, P. 196-206, 2001.
3. Kogel V.D., Joiner A.J., Editors M.C., Basic Clinical Radiobiology: 4th edition; Hodder Arnold, London, UK., 2009.
4. Kuzin A.M., Structural and metabolic theory in radiobiology, Nauka, Moscow, 1986 (in rus.)
5. UNITED NATIONS SCIENTIFIC COMMITTEE on the Effects of Ionizing Radiations: Sources and Effects of Ionizing Radiations, Report 1994, Annex A: Epidemiological studies of radiation carcinogenesis, New York: United Nations, 1994.
6. UNITED NATIONS SCIENTIFIC COMMITTEE ON THE EFFECTS OF ATOMIC RADIATIONS UNSCEAR: Sources and effects of ionising radiation, United Nations, New York, 2000.
7. Yarmonenko S.P., Radiobiology of humans and animals, Moscow, 2004. (in rus.)

RADIATION DETECTION AND CONTROL

Authors: Andrey I. Timoshchenko, Ph.D. (Physics), Associate professor; Ermolenko Natalia, senior lecturer

Total hours: 160
Lectures - 30
Laboratory classes - 16
Practical lessons – 4
Self-study work – 110

Form of control: exam
Nr. of ECTS Credits: 4,5
Semester: 2
Course Level – 1st year MA

Goals of the course – Students are to become familiar with basic radiation measurement techniques and methodologies and should be ready to apply them in environmental radiation monitoring, radiation monitoring of working places, individual dosimetry.

Learning outcomes of the:

Professional/disciplinary skills:

- to understand dosimetric quantities and their measurement units and to perform related calculations;
- to be familiar with the different types of radiation detectors and their operating principles, characteristics and limitations;
- to be able to choose the appropriate detector for a given radiation field and dosimetric quantities.

***Personal skills*:**

- use of basic radiation measurement instruments;
- interpretation of readingss and processing data;
- basic methods of calibration of radiation measuring devices;
- basic radiometric and dosimetric calculations

Short content:

1. Quantities and units. Radiometric quantities and interaction coefficients: Radiation field; fluence (rate); energy fluence (rate); cross section; mass attenuation coefficient; mass stopping power. Dosimetric quantities: absorbed dose (rate); kerma (rate); Exposure (rate); concepts of dosimetry: energy imparted; lineal energy; linear energy transfer (LET),; organ dose. Radiation protection and operational quantities: The radiation weighting factor w_R in terms of unrestricted linear energy transfer in water; equivalent dose; tissue weighting factor w_T; effective dose; aligned and expanded field; personal dose equivalent Hp (0.07) and Hp(10); the ambient dose equivalent H*(d) and the directional dose equivalent (H'(d)).

2. Radiometric and dosimetric calculations. Relationship between fluence, kerma and absorbed dose; air kerma rate constant; calculation of kerma and absorbed dose. Point sources, absorption and scattering in air and in the body; attenuation of primary radiation and buildup of secondary radiation. Calculation of dose from neutron sources.

3. Basic principles of radiation detection and measurement. General properties of radiation detectors. Energy and efficiency (geometric and intrinsic) calibration, background, geometry, statistics; pulse counting scalers and rate meters; discriminators; resolution; pulse height analysis - coincidence and anticoincidence; pulse shape analysis; dead-time correction; computer analysis of spectra.

4. Gaseous detectors. Bragg-Gray cavity principle; measurement of absorbed dose with ionization in gas filled cavity; electronic equilibrium; composition of homogeneous cavity; large cavity; small cavity; recombination effects; correction factors for determination of absorbed dose to water in photon and electron beams. Gas filled detectors: Ionization chambers with current

measurements; pressure ionization chamber; extrapolation chambers; proportional chambers; GM tubes.

5. Scintillation detectors. Solid and liquid scintillators; quenching. Semiconductor detectors. Photographic emulsions.

6. Other types of detectors. Thermoluminescent detectors. Tissue equivalent detectors. Nuclear track detectors. Neutron detectors. Comparison of the various types of detectors for appropriate measurement purposes. Other detectors: electrets; self-powered detectors; thermally stimulated exoelectron emission (TSEE); radiophotoluminescent detectors (RPLD).

Themes of laboratory classes:

1. Determination of characteristics of Geiger–Müller detectors: counting rate versus voltage curve; response to different radiation energies
2. Calibration of a gamma scintillation spectrometer or semiconductor spectrometer in terms of energy and activity
3. Calibration of beta spectrometer by maximum energy of the spectra
4. Identification of unknown radionuclides by Feather analysis method

Themes of practical classes:

1. Calculation exercises on quantities
2. Calculation exercises on quantities in mixed radiation field

Readings:

1. Absorbed dose determination in external beam radiotherapy: international code of practice for dosimetry based on standards of absorbed dose to water. TRS No. 398, IAEA, April, 2004.
2. Attix, F.H., Introduction to Radiological Physics and Radiation Dosimetry, Wiley, New York, 1986.
3. INTERNATIONAL COMMISSION ON RADIATION UNITS AND MEASUREMENTS, Quantities and Units in Radiation Protection Dosimetry, Report No. 51, ICRU, Bethesda, MD, 1993.
4. INTERNATIONAL COMMISSION ON RADIATION UNITS AND MEASUREMENTS, Fundamental
5. Knoll, G.T., Radiation Detection and Measurement, 3rd Edition, Wiley, New York, 2000.
6. Sabol J., Weng P.-S. Introduction to radiation protection dosimetry. WorldScientific, Singapore, 1995
7. Quantities and Units for Ionizing Radiation, Report No. 60, ICRU, Bethesda, MD, 1998.

RADIOECOLOGYCAL MONITORING AND ANALYSIS

Author: Nadezhda V. Goncharova , Professor, Ph.D. (Biological Science, plant physiology)
Total hours: 160
Lectures - 20
Seminars - 10
Laboratory classes - 20
Self-study work -110

Form of control: exam
Nr. of ECTS Credits: 4,5
Semester: 1; 2
Course Level –2nd year MA

Goals of the course:
- understanding how standard sampling and analytical techniques have been developed to assess contaminant levels for a variety of media, including water, air, and living systems (bio-markers and microbiology);
- learn the mechanisms analytical skills, including defining a problem, determining appropriate uses and limitations of data, selecting and defining variables relevant to the problem;
- give bases to understand the primary focus on recognition and evaluation of contaminants, including data interpretation for risk reduction and regulatory compliance;

Learning outcomes of the:
Professional/disciplinary skills:
- use knowledge to general methods of epidemiology, measurements of radiation exposure and retrospective dose assessments, quantification of radiation late effects and calculation of risk factors;
- use of modern environmental investigative techniques, instrument selection, and quality control, including documentation, calibration, and sample management;
- use knowledge about multi media sampling techniques and analytical methods for evaluation outdoor/indoor air, soil/surfaces, and water.

Personal skills:
- use the knowledge in practice and professional activities;
- carry out an independent search, systematization and analysis of information;
- independently carry out tasks and analyze the result.

Short content:

1. Principles of radiation epidemiology. Represent fundamental concepts, research methods, and application areas in environmental epidemiology.

2. The Chernobyl accident, health effects in the affected populations. The lecture is divided into three parts. Part one deals with the power plant catastrophe in 1986, part two deals with the repercussions of radioactive radiation and the third part describes the health effects of radiation.

3. Estimation of radiation doses from exposure to radioiodines in Belarus. Lecture provide a detailed and systematic overview thyroid Dose Estimates for a Cohort of Belarusian Children. Exposed to Radiation from the Chernobyl Accident and measures of Thyroid Function among Belarusian Children and Adolescents Exposed to Iodine-131 from the Accident at the Chernobyl Nuclear Plant.

4. The accidents at Chernobyl and Fukushima, comparison of accidents, radioactive releases, countermeasures and health impact on rescue workers and the general population. Radioactive release.Health effects,Comparison with other accidents.

5.Medical responses to reactor accidents. Design and results of epidemiological studies after medical radiation exposure, past and future.

6. Mathematical modelling of radionuclide transport in the environment, including

applications of compartmental models.

7. Dosimetry, practical measurements and theoretical modelling, instrumentation, antennas

8. Radiation dosimetry for highly contaminated Belarusian, Russian and Ukrainian populations, and for less contaminated populations in Europe.

9. Radionuclide dispersion in groundwaters, terrestrial surface waters, estuaries and marine environments.

10. Uptake of radionuclides by plants and animals. .Assessment of critical group and collective exposures.

Themes of seminars:

1. Factors impacting on the ecosystem transfer of radionuclides.
2. Dose commitment from incorporated radionuclides in medicine and from environmental contamination.
3. Use of isotope techniques in environmental chemistry.
4. Modelling atmospheric dispersion and deposition of radionuclides after nuclear accidents
5. The worldwide net of measurements of radioactivity distribution after the Fukushima accident

Themes of laboratory classes:

1. Detection and measurement of radioactivity.
2. Principles of sampling and analytical methodology.
3. Soil horizont classification and description.

Readings:

1. "Accident at Windscale No.1 Pile on 10 October 1957". Cmnd. 302. (H.M.S.O., 1958).
2. "Accident at Windscale: World's First Atomic Alarm", Hartley Howe. *Popular Science*, October 1958, Vol. 173, No. 4.
3. "An Assessment of the Radiological Impact of the Windscale Reactor Fire", M.J. Crick, G.S. Linsley. NRPB Reports, Oct. 1957, Nov. 1982.
4. "Chernobyl: worst but not first", Walter C. Patterson. Bulletin of the Atomic Scientists, August/September 1986.
5. "Windscale fallout blew right across Europe", Rob Edwards. *New Scientist*, October 6, 2007.
6. Accident at Windscale' British Medical Journal 16 Nov 1957;2 (5054) pp 1166-8.
7. An airborne radiometric survey of the Windscale area, October 19–22nd, *1957*. A.E.R.E. reports, no. R2890. (Atomic Energy Research Establishment).
8. Baker, R. J. and R. K. Chesser. 2000. The Chernobyl nuclear disaster and subsequent creation of a wildlife preserve. *Environmental Toxicology and Chemistry*. 19:1231-1232.
9. Baker, R.J., M.J. Hamilton, R.A. Van Den Bussche, L.E. Wiggins, D.W. Sugg, M.H. Smith, M.D. Lomakin, S.P. Gaschak, E.G. Bundova, G.A. Rudenskaya, and R.K. Chesser. 1996. Small mammals from the most radioactive sites near the Chernobyl nuclear power plant. *Journal of Mammalogy*. 77:155-170.
10. Matson, C. W., B. E. Rodgers, R. K. Chesser and R. J. Baker. 2000. Genetic diversity of Clethrionomys glareolus populations from highly contaminated sites in the Chernobyl region, Ukraine. Environmental Toxicology and Chemistry. 19:2130-2135.
11. Secrets of the Windscale fire revealed', F. Pearce. New Scientist vol 99 29 September 1983 p. 911
12. The deposition of strontium 89 and strontium 90 on agricultural land and their entry into milk after the reactor accident at Windscale in October, 1957. A.H.S.B. (United Kingdom Atomic Energy Authority).
13. The Windscale reactor accident--50 years on' R. Wakeford. Journal of Radiological Protection 2007 Sep vol. 27(3) pp211-5. Epub Aug 29,2007
14. Windscale, 1957: Anatomy of a Nuclear Accident, Lorna Arnold. New York : St. Martin's Press, 1992
15. 'Windscale; increased cancer incidence alleged', T. Beardsley. Nature vol 306 Issue 5938 Nov 3 1983 p. 5

LEGISLATIVE ASPECTS OF HUMAN SECURITY ON RADIONUCLIDE POLLUTED AREAS

Author: Input of WP 4 (BSU)
Total hours: 108
Lectures - 24
Seminars – 12
Self-study work - 72

Form of control: credit
Nr. of ECTS Credits: 3
Semester: 3
Course Level: 2nd year MA

Goals of the course – to form the system of knowledge about the legal regulation of public relations in the field of human security on territories of radioactive contamination at both the national and international level and the study of constitutional, environmental, agricultural, land, administrative, civil, financial law, public international and foreign trade law.

Learning outcomes of the course

Professional/disciplinary skills:

Students should be able to:

- apply general and specific scientific methods to characterize patterns and features of the legal support for human security on territories of radioactive contamination;
- determine the essential characteristics of the legal relations in the field of human security on territories of radioactive contamination and to analyze their content;
- characterize the state of and trends in the development of legislation in the field of human security on territories of radioactive contamination;
- carry out an independent search, systematization and analysis of information on specific legal issues of human security on territories of radioactive contamination.

Personal skills:

Students can use the knowledge and skills acquired for carrying out an independent analysis of the rules of law covering relations in the field of human security on territories of radioactive contamination for purposes of their usage in law enforcement practice and professional activities, as well as to express competently and justify position on the main issues of the course.

Short content:

1. General characteristics of the legal support for human security on territories of radioactive contamination. Definition of legal support for human security on territories of radioactive contamination. Historical background of the formation and development of legislation for providing human security on territories of radioactive contamination. System of legislation to provide for human security on territories of radioactive contamination. International documents as sources of legal support for human security on territories of radioactive contamination. Institutional frameworks of human security on territories of radioactive contamination

2. The legal status of territories of radioactive contamination. Legal concept and composition of territories of radioactive contamination. Legislation on the regime of territories of radioactive contamination. System and competence of government in the area of the regime of territories of radioactive contamination. Legal regulation of radiation monitoring, control, norming, recording, licensing in territories of radioactive contamination. The legal regime of radiation-hazardous lands. Legal liability for violation of the regime of territories of radioactive contamination.

3. Legal provision of radiation safety on territories of radioactive contamination. Radiation safety law. The human right to radiation safety. Public government in the area of radiation safety. The legal requirements for radiation safety.

4. Legal support of agricultural production and foods security on territories of radioactive contamination. Legal support of agricultural products producing on territories of radioactive contamination under national and international radionuclides regulations. Legal protective measures for agriculture on territories of radioactive contamination. Legal aspects of radiation safety of citizens working in agriculture on territories of radioactive contamination. Legal support of agricultural products and food quality and security on territories of radioactive contamination.

5. Legal support of environmental security on territories of radioactive contamination. Legal aspects of nature use and protection on territories of radioactive contamination. Legal measures of environmental protection against radioactive waste impact. Legal protection of environment in settlements within territories of radioactive contamination.

6. Legal regulation of health protection on territories of radioactive contamination. Legal provision of medical aid to citizens on territories of radioactive contamination. The legal basis of medical control for citizens' health state on territories of radioactive contamination. Legal measures of health protection during medical irradiation. Legal provision of medical rehabilitation of people affected by radiation accidents or living on territories of radioactive contamination. Legal basis for providing citizens by medicaments, medical items and equipment

7. The legal status of citizens on territories of radioactive contamination. The system of legislation to ensure the rights of citizens on territories of radioactive contamination. Environmental rights (access to information and public participation in decision-making related to the environment on territories of radioactive contamination, etc.). Social protection of citizens affected by radiation accidents: pensions, the right of citizens affected by radiation accidents for benefits, the rights of citizens affected by radiation accidents in health care. Social protection of the citizens residing on territories of radioactive contamination. Social protection of citizens working on territories of radioactive contamination. Additional guarantees for certain categories of citizens.

8. Fundamentals of international law in sphere of human security on territories of radioactive contamination

Themes of seminars:

1. Legal status of territories of radioactive contamination.
2. Legal provision of radiation safety on territories of radioactive contamination.
3. Legal support of agricultural production and foods security on territories of radioactive contamination.
4. Legal support of environmental security on territories of radioactive contamination.
5. Legal regulation of health protection on territories of radioactive contamination.
6. The legal status of citizens on territories of radioactive contamination.

Readings:

1. National legal acts
2. International legal acts
3. Literature to be filled further

RADIATION BIOCHEMISTRY

Author – Natalya V. Prokopenko, Associate Professor, Ph. D. (Biological Science, radiobiology)
Total hours: 120
Lectures - 30
Laboratory classes - 16
Seminars – 12
Self-study work - 62

Form of control: credit
Nr. of ECTS Credits: 3
Semester: 2
Course Level, Year – 1st year MA

Goals of the course:
- give the up-to-date knowledge on the effects of radiation on biomolecules, organs, tissues, systems of the organism;
- learn the mechanisms of molecular determination of radiation response;
- study the mechanisms for the formation of free radicals and their subsequent reactions;
- give bases to understand the principles and methods of radiation protection;
- understanding the relationships between radiation exposure and biological damage;
- master the methods to the detection of molecular markers of the damaging effects of ionizing radiation.

Learning outcomes of the course
Professional/disciplinary skills:
- use knowledge to analyze the structural and functional changes in biological molecules caused after irradiation;
- muse of modern biochemical and biophysical methods to determine the content of free radicals in cells and body fluids of irradiated organism;
- use knowledge for the estimation radiobiological effect;
- be able to evaluate the effectiveness of radioprotectors.

Personal skills:
- use the acquired knowledge in practice and professional activities;
- carry out an independent search, systematization and analysis of information;
- independently carry out tasks and analyze the result.

Short content:

1. Introduction to radiation biochemistry. The main provisions of the radiation biochemistry. General characteristics of ionizing radiation. Interaction of radiation with matter. The basic properties of ionizing radiation: linear ionization density, linear energy transfer and relative biological effectiveness. Radiation damages of the body over time and the level of destruction of the body.

2. The primary processes of energy absorption of ionizing radiation. Direct and indirect effects of ionizing radiation. Radiolysis of water. Free radicals. Some typical radicals' reactions. Characteristics of oxygen products. Superoxide ($O^{-\bullet}_2$). Hydrogen peroxide (H_2O_2). Hydroxyl radicals ($OH^{\bullet}$). Nitrogen monoxide (NO•). Peroxynitrite ion ($ONOO^-$). Hypochlorous acid (HOCl). The oxygen effect. Mechanism of action of chemical modifiers of radiosensitivity. Dilution effect. Quantitative assessment of radiation-induced reactions with the direct and indirect effect of radiation.

3. The action of radiation on nucleic acids and nucleoproteins, proteins, peptides and amino acids, lipids. Radiation-induced transformations of pyrimidine and purine, nucleosides and nucleotides. The effect of radiation on the molecular structure of DNA, RNA *in vitro* and *in vivo*. The influence of radiation on the exchange of nucleic acids in the cell. Repair of DNA lesions.

Excision-resynthesiss. Photorestoration. Recombination or post-replication repair. SOS repair. Repair of double-strand breaks

The primary physical and chemical processes of radiation damage to proteins. The formation of secondary radicals. Radiosensitivity of amino acids. The effect of radiation on the structure and function of proteins. The action of radiation on the biosynthesis of proteins and enzymes, on the *in vivo* activity of enzymes.

Radiation-induce changes of simple carbohydrates (radiolysis of pentoses and hexoses). Effects of ionizing radiation on the oligosaccharides, mucopolysaccharides. Radiolysis glucose-polymers. The metabolism of carbohydrates after irradiation of the whole organism.

Radiation damage of biological membranes. Lipid peroxidation. System of repair of the cell membrane. Radiation-chemical transformations of fat-containing vitamins, steroids and coenzyme. Hormonal status of the body after irradiation. Formation of toxic substances in the irradiated organism.

4. Radiation-biochemical changes in the systems, organs and tissues of the body. Acute and chronic radiation sickness. Radiation syndromes: hemopoietic syndrome; gastrointestinal syndrome; central nervous system syndrome. Other acute effects (skin, gonads, eyes). Biochemical changes in the tissue fluids in acute radiation sickness. Acute radiation sickness from uneven exposure. Local radiation injuries. Chronic radiation sickness caused by total and incorporates radiation. Biochemical parameters and the overall condition of organs and systems in chronic irradiation. The principles of treatment of acute and chronic radiation diseases.

5. The antioxidant system. Classification, functions and characteristics of antioxidants. Enzymatic components of the antioxidant system. Natural antioxidants. Extracellular antioxidants. The mechanism of inactivation of free radicals and products of radiolysis by natural antioxidants.

6. Radiation protection. Radioprotectors. Classification. The mechanism of radioprotectors action. The criteria for the applicability of radioprotectors. Dose modifying factors (DMF).Comparison of the efficacy of different protectors. Chemical modifies of radiosensivity. The substances prevent the absorption and accelerate the elimination of radioactive substances from the body.

Themes of laboratory classes:

1. Radiochemical yield of the products of water radiolysis.
2. Determination of the intensity of the lipid peroxidation in cells and body fluids after irradiation.
3. Determination of the antioxidant activity of biological fluids after irradiation.
4. Comparison of the efficacy of different protectors.

Themes of seminars:

1. Radiobiological effects of low doses of radiation.
2. The oxygen effect.
3. Radiation biochemistry of biopolymers.
4. Acute and chronic radiation sickness.
5. Changes in the systems, organs and tissues of irradiated organism.
6. Principles and methods of radiation protection.

Readings:

1. Cember H., Jonson T., Introduction to Health physic, McGraw-Hill Companies, eBook, 2009
2. Granier R., Gambini D., Lisker R., Applied Radiation biology and protection., Ellis Horwood, 1990
3. Kuzin A.M., Structural and metabolic theory in radiobiology, Nauka, Moscow, 1986 (in rus.)
4. Kuzin A.M., Radiation biochemistry. Israel Program for Scientific Translations, 1964
5. Rolevich I.V., Dorozhko S.V., Morzak G.I., Radiation safety: Manual, RIVSH, Minsk, 2010. (in rus.)

6. Tubiana M., Dutreix J., Wambersie A., Introduction to radiobiology. Taylor&Francis, London, 1990
7. Sen C., Packer L., Hanninen O., Handbook of Oxidants and Antioxidants, Elsevier Science B.V., Amstardam, 2000
8. Stozharov A.N., Radiation medicine, Ministry of Finance, Minsk, 2010. (in rus.)
9. Yarmonenko S.P., Radiobiology of humans and animals, Moscow, 2004. (in rus.)

RADIOTOXICOLOGY AND RISK ASSESSMENT

Author – Nadezhda V. Goncharova, Professor, Ph.D. (Biological Science, plant physiology)
Total hours: 104
Lectures - 30
Seminars – 22
Self-study work - 52

Form of control: credit
Nr. of ECTS Credits: 2.5
Semester: 1
Course Level – 1st year MA

Goals of the course:
- give the modern knowledge about the effect of ionizing radiation on micro- organisms, plants and animals as well as on natural and semi-naturals ecosystems;
- understanding global atmospheric circulation and biogeochemical cycles in general, as a result of the study of transfer of radionuclides, which acted as tracers;
- learn the mechanisms dispersion and transfer radionuclides between environmental compartments and along food chains and food webs;
- give bases to understand the effects of ionizing radiation on most non-human species and whole ecosystems.

Learning outcomes of the course:
Professional/disciplinary skills:
- understanding global atmospheric circulation and biogeochemical cycles in general, as a result of the study of transfer of radionuclides, which acted as tracers;
- learn the mechanisms dispersion and transfer radionuclides between environmental compartments and along food chains and food webs;
- give bases to understand the effects of ionizing radiation on most non-human species and whole ecosystems.

Personal skills:
- understand many of the fundamental principles toxicology
- develop knowledge based on a series of inter-related scientific principles and understand how and why toxicological processes and events occur
- appreciate and conceptualize the complexity of toxicological issues and gain insight into the full breadth of the field of toxicology.

Shot content:

1. **People and the environment.** There is increasing public interest and concern over matters of human health and environmental quality. Toxicology, the study of adverse effects of chemical contaminants on living systems, forms the basis of our ability to predict and prevent adverse effects to human health and the environment .Without an understanding of the basic principles of toxicology, one cannot make a fully informed decision about the true risks and benefits of anthropogenic and natural chemicals to humans and other organisms.
2. **Principles of toxicology.** Introduces students to the basic principles of toxicology. Will cover the history and scope of the field; absorption, distribution, metabolism and elimination of toxicants; target organ toxicity; mechanisms of toxic action; carcinogenesis; environmental toxicology as well as human and ecological risk assessment.
3. **Environmental toxicology and chemistry.** Provides students with an appreciation and understanding of the principles of environmental toxicology and chemistry including the sources, fate, and effects of chemicals in the environment. Emphasis is on contemporary problems in human health and the environment.

4. Fate and transport of chemicals in the environment. Identification of toxicants and their sources in the environment; equilibrium partitioning of chemicals in the environment (between air, water, soil, sediment, and biota) using physico-chemical properties; transport and chemical transformations of chemical compounds in air, water, and soil media. Case studies of fate and transport of selected toxic chemicals.

5. Principles of radiotoxicology. The structure-activity and dose-response relationships of environmental toxicants; their absorption, distribution, metabolism, and excretion; and evaluation of their toxicity and factors that influence toxicity. Quantitative methods in measuring acute and chronic toxicity.

6. Mechanisms of toxicity. Biochemical and physiological mechanisms underlying the toxicity of environmental toxicants. The interaction of toxicants with subcellular components and macromolecules with emphasis on mechanism of action, in particular neurotoxicity of pesticides, chemical carcinogenesis, mutagenesis, and teratogenicity.

7. Cancer biology. The origin, development, and treatment of cancer are explored with emphasis on molecular mechanisms. Topics such as oncogenes, tumor suppressors, cell cycle and differentiation, AIDS, heredity and environmental factors in the development of cancer are covered.

8. Analysis and identification of environmental toxicants. Provides laboratory experience in specialized methods of identification and analysis of toxic organic compounds in gaseous, aqueous, and soil media. Methods of sample collection and extraction are presented. Students utilize both gas and liquid chromatographic techniques. Toxicant analysis by gas chromatography (GC), GC/mass spectrometry, and GC/Fourier transform infrared spectroscopy is emphasized.

9. Biotransformation of organic chemicals. Explores the catalytic activities and regulatory pathways of Phase I (e.g. cytochromes P450) and Phase II (e.g. UDPGT) enzymes involved in organic chemical biotransformation. Demonstrates the contribution of biotransformation in toxicology.

10. Biodegradation of xenobiotic chemicals. The importance of microorganisms in metabolizing synthetic organic chemicals. Ecology, physiology, growth, isolation, and identification of degradative bacteria. Studies of catabolic pathways: metabolites, enzymes, genes, and environmental factors. Bioremediation processes and environmentally related problems.

11. Environmental and molecular carcinogenesis. Molecular genetics of human cell response to environmental carcinogens. Discussion of DNA repair, mutagenensis, oncogenes, and tumor suppressors. Following presentation of introductory material, emphasis will be placed on student discussion of recent literature.

12. The science of radioecotoxicology. Establishing the international basis for ecological risk assessment. Current developments in ecotoxicology and ecological risk assessment.

13. Radioecological risk assessment and multiple stressors. Scientific basis for radioecotoxicology, ecological risk assessment and multiple stressors. radioecotoxicological approaches and perspectives.

14. Methods and tools in radioecotoxicology and radioecological risk assessment. Protecting the environment against ionizing radiation. Eco-epidemiology: a means to safeguard ecosystem services that sustain human welfare. Radionuclides: ecological and human health effects.

15. Radioecotoxicology and toxicity monitoring. Assessment of ecological risk caused by the long-living radionuclides in the environment. Effects of contaminant exposure on plants: implications for ecotoxicology and radiological protection of the environment. Radioactive contaminated food products and exposure dose of the population.

Themes of seminars:

1. Methods and tools in radioecotoxicology and ecological risk assessment.
2. A habitat suitability evaluation technique and its application to environmental risk assessment.
3. The QnD Model/Game System: integrating questions and decisions for multiple stressors.
4. The bioindicators: an experimental model in environmental toxicology.
5. Effect of radioactive or chemical contamination on plants intercalary meristems cells.

6. Application of GIS technologies in ecotoxicology: a radioecological case study.
7. Ecotoxicology and toxicity monitoring.
8. Hazard Identification
9. Toxicity Assessment
10. Emphasis is placed on contemporary problems in human health and the environment.

Readings:

1. 20 Years after the Chernobyl Catastrophe: the consequences in the Republic of Belarus and their overcoming. National report// Edited by V.E. Shevchuk, V.L. Gurachevsky – Minsk: Committee on the Problems of the Consequences of the Catastrophe at the Chernobyl NPP under the Belarusian Council of Ministers. 2006. – 104 p.
2. Commission of the European Communities.Underlying Data for Derived Emergency Reference Levels.1991, Post Chernobyl Action, Rep. EUR 12553-en, CEC, Luxembourg.
3. Giese., et al., 1989, Radiocesium transfer to whey and whey products: whey decontamination on an industrial scale. Radioctivity Transfer during Food Processing and Culinary Preparation (Proc. Seminar Cadarache), CEC, Luxembourg, pp. 295-308.
4. Goncharova N.V., Bairasheuskaya D.A. Risk assessment: radioactive contaminated food products and exposure dose of the population// G. Arapis et al. (eds.), Ecotoxicology, Ecological Risk Assessment and Multiple stressors – 2006 Springer, P. 181–189
5. Hove K and Strand P,1990, Prediction for the duration of the Chernobyl radiocaesium problem in non-cultivated areas based on a reassessment of the behavior of fallout from Nuclear weapons tests. In:Flitton S, Katz EW(Eds), Environmental contamination following a major nuclear accident. IAEA 306.1: 215-223.
6. Noorduk H., and Qunault J.M, 1992. The influence of food processing and culinary preparation on the radionuclide content of foodstuffs: A review of available data, Modeling of Resuspension, Seasonality and Losses during Food Processing, First report of the VAMP Terrestrial working Group, IAEA-TECDOC-647, Vienna pp. 35-59.
7. Schell W.R and Linkov I, 2001.Transfers in forest ecosystem In: Radioecology: Radioactivity and Ecosystems E. Van der Stricht and R.Kirchmann (Eds) pp. 136-158
   Strand P;.,Howard B and Averin V.1996, Fluxes of radionuclides in rural Communities in Russia, Ukraine and Belarus. Post-Chernobyl action report. Commision of the European Communities.

PSYCHOLOGICAL REHABILITATION

Author – Elena V. Tolstaya, Associate professor, Ph.D. (Medical Science)
Total hours: 160
Lectures - 22
Practical lessons – 36
Self-study work - 102

Form of control: exam
Nr. of ECTS Credits: 4
Semester: 2
Course Level – 1st year MA

Goals of the course – to know the psychological influence of nuclear accidents, psychological special features of the population suffered from them and the methods of psychological diagnostics and rehabilitation.

Learning outcomes of the course

Professional/disciplinary skills:

- ability to identify persons with psychological distress;
- ability to render psychological assistance in acute traumatic situation;
- ability to prevent/decrease the development of radioanxiety/radiofobia;
- ability to enlighten people about psychological rehabilitation;

Personal skills:

- ability to work individually as well as in the team;
- ability to overcome psychological trauma.

Short content:

1. Mental health. Factors influencing on mental health. Methods of examination of psychological status. Social and psychological distress: mechanisms of their development and their signs. Methods of determination of psychological and social distress. Methods of determination of psychological resistance and personal resources

2. Nuclear accident/disaster as psychological trauma. Psychological consequences of the disaster on Chernobyl NPP (other nuclear accidents/disasters) on different stages of its (their) consequences. Social and economic consequences influencing on psychological state. Psychological special features of different groups of suffered population, children and adolescents. Development of radioanxiety/radiofobia and its prophylactics.

3. Psychological rehabilitation. Common knowledge about psychological rehabilitation. Methods of overcoming of psychological trauma. Psychological hygiene and prophylactics. Role of ecological and health education in prophylaxis of psychological distress.

4. Stress-management. Methods of psychological rehabilitation, its peculiarity in children and adolescents. Cognitive and behavioral rehabilitation. Psychological rehabilitation in health-improving and rehabilitation centers/ sanatoriums.

Themes of seminars:

1. Nuclear accident/disaster as psychological trauma. Urgent psychological assistance.
2. Psychological consequences of the disaster on Chernobyl NPP (other nuclear accidents/disasters) on the stage of remote consequences.
3. Methods of examination of psychological status.
4. Social and psychological distress: mechanisms of their development and their signs.
5. Determination of social and psychological distress.
6. Determination of psychological resistance and personal resources.
7. Psychological hygiene and prophylactics.
8. Stress-management.

9. Methods of psychological rehabilitation.
10. Cognitive and behavioral rehabilitation.
11. Psychological special features of children and adolescents and peculiarity of their psychological rehabilitation.
12. Psychological rehabilitation in health-improving and rehabilitation centers/ sanatoriums.
13. Ecological and health education as prophylaxis of psychological and social distress.

Readings:

1. Anxiety disorders/ ed. D. Nutt & J. Ballenger. Oxford: Blackwell Publishing, 2005.
2. Environmental anthropology Annual proceeding Minsk Belorussian committee "Chernobyl children" 1997-2007
3. International journal of radiation medicine 1999 – 2003.
4. Grebenkov S.V. Postchernobyl syndrome: keeping health of military men and population in the condition of unstable by radiation environment. - St-Petersburg, 2004.
5. Grinberg D. Stress-management. - St-Petersburg, 2002.
6. Human consequences of the Chernobyl nuclear accident: A strategy for recovery// A report commissioned by UNDP and UNICEFF with support of UN-OCHA and WHO, 6 February 2002.- Ukrain: UNICEF, 2002. – 75
7. Health effects of Chernobyl accident: Monograph in 4 parts/ed. A. Vozianov, V. Bebeshko, D. Bazyka. – Kiev. DIA, 2003.
8. Nyagu A., Loganovsky K. Neuropsychiatric effects of ionising radiation.- Kiev, 1999.
9. Proceedings of 2nd international conference "Long-term health consequences of the Chernobyl disaster// ed. A.L. Nyagu, G.N. Souchkevich, Kiev: "Chernobylinform", 1998.
10. Proceedings of 2nd international conference "Mental health consequences of the Chernobyl disaster: current state and future prospects", May, 24-28, 1995. – Kiev, 1995.
11. Servan-Sheiber D. Antistress.-Moscow, 2012.

MEDICAL AND ENVIRONMENTAL REHABILITATION

Author – Elena V. Tolstaya, Associate professor, Ph.D. (Medical Science)
Total hours: 268
Lectures - 34
Practical lessons – 54
Self-study work – 180

Form of control: exam
Nr. of ECTS Credits: 7
Semester: 1, 3
Course Level –1st and 2nd year MA

Goals of the course: to give the knowledge and practical skills in the field of keeping the health and rehabilitation of the population living in contaminated with radionuclides areas and rehabilitation of this environment.

Learning outcomes of the course

***Professional/disciplinary skills*:**

- ability to use data about the level of radiation in environment (including microenvironment) for giving recommendations for their normalization (optimization, lowering);
- ability to take part in working out the complex prophylactic and rehabilitative measures using expert information about the level of radiation in environment and health state in different groups of the population undergoing (undergone) radiation influence as well as during nuclear incidents, accidents and disasters;
- ability to educate the population in the fields of healthy style of life and radiation safety.

***Personal skills*:**

- ability to work individually as well as in the team;
- ability to make conclusions using expert data.

Short content:

1. Medical and environmental rehabilitation. Common knowledge about medical and environmental rehabilitation and its methods.

2. Influence of radioactivity/radionuclides in environment on the health of the people. Usual influence of radiation in settlements, buildings and during medical procedures. Radionuclides as xenobiotics, incorporation of radionuclides, their complex influence on health with other chemical substances. The state of the health of the population suffered from nuclear incidents, accidents and disasters, nuclear testing and atomic bombing in different stages of their consequences. Mental and reproductive health of the population, suffered from nuclear accidents and disasters.

3. Nutrition influences on the health state of population, living on contaminated areas. Influence of disbalanced nutrition on mental and physical state. The contamination of the food and its influence on the health. Methods of keeping and processing of food stuffs.

4. Rehabilitation of the polluted environment. Prevention/decrease of radioactive influence in buildings. Nuclear incidents, accidents and disasters, liquidation of the environmental problems in their different stages. Rehabilitation of the lands, contaminated with radionuclides, including agricultural approaches.

5. Approaches to health improvement and rehabilitation and their methods. The aproaches to sanogenesis activation and radionuclides detoxication. Iimmunological correction. Physical rehabilitation. Physiotherapy. Phytotherapy. Reflexotherapy. Diet therapy. Methods of complementary medicine (homeopathy, aromatherapy, color-therapy, osteopathy). Rehabilitation in health improving and rehabilitation centres.

6. Ecological and health education. The knowledge about healthy life style. Peculiarity of healthy life style in contaminated with radionuclides regions. The approaches and methods of health and ecological education.

Themes of seminars:

1. Medical and environmental rehabilitation (total approach).
2. Usual influence of radiation in settlements, buildings and during medical procedures.
3. Nuclear incidents, accidents and disasters, medical and environmental problems in different stages of their consequences.
4. The liquidation of the consequences of nuclear incidents, accidents and disasters.
5. The influence of nuclear disasters on the health state of their liquidators.
6. Radionuclides as xenobiotics, their complex influence with other chemical substances.
7. The state of the health of the population, suffered from nuclear accidents and disasters, nuclear weapon test and atomic bombing.
8. Mental health of the population, suffered from nuclear accidents and disasters.
9. Reproductive health of the population, suffered from nuclear accidents and disasters.
10. The influence of the nutrition on the state of the health (foodstuff, methods of their keeping and processing).
11. Rehabilitation of the lands, contaminated with radionuclides.
12. Healthy life style on the territories contaminated with radionuclides.
13. Ecological and health education.
14. Sanogenesis activation as a main approach in medical rehabilitation. Immunological correction.
15. Physical rehabilitation (total approach and methods).
16. Physiotherapy (total approach and methods).
17. Phytotherapy.
18. Diet therapy.
19. Methods of complementary medicine (homeopathy, aromatherapy, color-therapy).
20. Health improvement and sanatorium treatment.
21. Health education.

Readings:

1. 20 years after Chernobyl disaster: consequences in Republic of Belarus and their overcoming/national report/ ed. V.E. Shevchuk, V.L. Gurachevsky. – Minsk, 2006. (in rus)
2. Chernobyl Nuclear Pour Station - Slavutich: medical aspects/ ed. V.G. Bebeshko, A.V. Nosovsky, D.A. Bazyki. – Kiev, 1996. (in rus)
3. Effects of A-bomb radiation on the human body/ ed. I. Shigematsu er all., Tokyo: Bunko Co., Ltd., 1995.
4. Environmental anthropology Annual proceeding Minsk Belorussian committee "Chernobyl children" 1997-2007
5. Grebenkov S.V. Postchernobyl syndrome: keeping health of military men and population in the condition of unstable by radiation environment. - St-Petersburg, 2004. (in rus)
6. Health effects of Chernobyl accident: Monograph in 4 parts/ed. A. Vozianov, V. Bebeshko, D. Bazyka. – Kiev. DIA, 2003. (in rus)
7. Human consequences of the Chernobyl nuclear accident: A strategy for recovery// A report commissioned by UNDP and UNICEFF with support of UN-OCHA and WHO, 6 February 2002.- Ukrain: UNICEF, 2002. – 75 p.
8. International journal of radiation medicine 1999 – 2003
9. International Chernobyl project "Estimation of radiological consequences and protective measures"/ report of International Consultative Committee, Vein: IAEA, 1992.
10. Nyagu A.,Loganovsky K. Neuropsychiatric effects of ionising radiation.- Kiev, 1999.
11. Proceedings of Belarus-Japan Symposium "Acute and late consequences of nuclear catastrophes: Hirosima-Nagasaki and Chernobyl" oct.3-5, Minsk, 1994 (in rus)

12. Proceedings of 2nd international conference "Long-term health consequences of the Chernobyl disaster// ed. A.L. Nyagu, G.N. Souchkevich Kiev: "Chernobylinform", 1998.
13. Proceedings of 2nd international conference "Mental health consequences of the Chernobyl disaster: current state and future prospects", May, 24-28, 1995. – Kiev, 1995. (in rus)
14. Proceedings of international conference "Remote consequences of exposure to ionizing radiation", Kyiv, May 23-25, 2007. (in rus)
15. Savchenko V.K. The ecology of the Chernobyl catastrophe. – Paris: UNESCO, 1997.
16. The problems of diagnostics and correction of health state in the condition of environmental tension: materials of the second international scientific conference St-Petersburg, 18-19 October 2006 . - St-Petersburg: Christmas, 2006. (in rus)
17. The Chernobyl accident: thyroid abnormalities in children, congenital abnormalities and other radiation related information/ Editor N. Takeichi. – Hiroshima. 1996.
18. Tolstaya E. Feeding as a factor of radioprotection in modern environmental conditions// abstracts of Satellite symposium "The Chernobyl impact on health and environment – a quarter later" September 2-3, 2011, Kyiv "Feeding as a factor of radioprotection in modern environmental conditions"- p. 132.

DATA ANALYSIS AND GIS IN RADIOBIOLOGY

Authors: Boris A. Tonkonogov, Ph. D. (Technical Engineering),
Vladislav V. Zhuravkov, Ph. D. (Biological Science)

Total hours: 76
Lectures - 10
Laboratory classes - 28
Self-study work - 38

Form of control: credit
Nr. of ECTS Credits: 2
Semester: 1
Course Level - 1st year MA

Goals of the course:
- principles and methods of data acquisition in radiobiology;
- foundations of application of modern mathematical, statistical and computational methods for data processing, analysis and visualization in different areas of radiobiology;
- geographic information systems and software for simulation and analysis (statistical, mathematical and spatial) to make adequate decisions in practical implementations

Learning outcomes of the course:
Professional/disciplinary skills:
- principles of data processing, analysis and visualization;
- mathematical, statistical and computational methods in radiobiology (radiation ecology, radiation medicine etc.);
- mechanisms of data management and interaction with program user interface;
- implementation of analytical and mathematical software.

Personal skills: Increasing of level of competence and applying of knowledge in practical and scientific experience for adequate decision-making.

Short content:

1. Introduction. Subject, goal and problems of the course. Short introduction, subject, goal and problems of the course according to radiobiological aspects connected with automated methods of processing, analysis and visualization of data using geographic information systems and software for simulation and analysis

2. Principles of data processing, analysis and visualization. Main principles of data processing, analysis and visualization in radiobiology based on spatially distributed experimental measurement data that characterizes contaminated areas by short-lived radionuclides in active phase of accident (or after a hypothetical accident) at nuclear power plants

3. Mathematical, statistical and computational methods in radiobiology. Contents and application of mathematical, statistical and computational methods in radiobiology for input data processing and creation on its' basis databases (information systems) and schematic maps of radioactive contamination of territories by short-lived radionuclides in active phase of accident at enterprise of nuclear fuel cycle.

4. Mechanisms of data management and interaction with program user interface. Using of mechanisms of data management and interaction with program user interface in radiobiology for access to data stored in databases (information systems) and building schematic maps

5. Implementation and development trends of analytical and mathematical software. Conclusion. Overview of implementation and development trends of analytical and mathematical software in radiobiology to make appropriate decisions based on allocation of territories that were heavily contaminated, as well as identification of regions where population should be given more attention during medical examination. Main conclusion

Themes of laboratory classes:

1. Formation of generalized data bank with cartographic and statistical information.
2. Mathematical and statistical processing of data and creation of databases for schematic maps.
3. Building, visualization, and analysis of schematic maps.

Readings:

1. Brown A., Feringa W., Colour basics for GIS users, Prentice Hall, 2003.
2. Johnson N., Leone F., Statistics and experimental design in engineering and the physical sciences, Wiley, New York, 1977.
3. Konoplya E. F , Mironov V. P., Zhuravkov V.V., Radiation and Chernobyl: Short-lived radionuclides in Belarus, Belorusskaya nauka, Minsk, 2008
4. Kraak M.-J. , Ormeling F., Cartography: visualization of geospatial data, Prentice Hall, Second edition, 2003.
5. Tonkonogov B. A., Gishkelyuk I. A., Kundas S. P., Visualization of environmental data, ISEU, Minsk, 2010.

SUSTAINABLE DEVELOPMENT

Author: Vladzimir N. Kapitsa, Ph.D. (Biological Science), Associate Professor
Total hours: 76
Lectures - 24
Practical lessons – 14
Self-study work - 38

Form of control: credit
Nr. of ECTS Credits: 2
Semester/ Term: 1
Course Level –1st year MA

Goals of the course – improve understanding sustainable development and possibilities to it's implication in practice.
Learning outcomes of the course:
Professional/disciplinary skills:
- must know the peculiarities of human-environment interaction, material flow in anthropogenic ecosystems;
- must know: principles Agenda XXI and Local agenda; principles sustainable development, it's strong and weak models; problems social, economic development and environmental protection and rational resource using for sustainable development of the region; restriction of development in radionuclide polluted territories. Possibilities supporting of human safety and economical and social development at polluted territories. Alternative possibilities for economical development radionuclide polluted region;
- be able to analyze material flow at the region, ecological footprint of the country, propose models of the region development for reducing environmental impact from human activity, support human safety and sustainable development of radionuclide polluted territories;
- be able to argue sustainable development models for polluted territories for human safety supporting.

Personal skills: be able
- to team work;
- to present his (her) analytical results;
- to decide problem tasks.

Short content:

1. Causes environmental degradation in modern world. Material flow differences in natural and anthropogenic ecosystems. "Limits of grow" by J. Forechester and D. Meadows. Environmental crisis and it's causes. Ecological footprint. Ecological rucksack.

2. Principles of sustaiable development. "Our common future" report Brundland's commission. Agenda XXI it's structure and tasks . National and local Agendaes. Balance between economic social and environmental interests. Strong and weak models of sustainability.

3. Renewable Energy. Renewable energetic as element for sustainable development - environmental and economic profits. Peculiarities renewable energy implementation for supporting human safeness and economic activation at radionuclide polluted territories.

4. Sustainable development peculiarities at radionucleid polluted territories. Local Agendas. Peculiarities of environment, social and economic development at radionuclide polluted territories. Restriction of development. Alternatives for economic development at polluted territories. Innovation for sustainable development.

5. Methods of minimization of radionuclide impact. Prediction of radionuclide accumulation in natural components. Methods of human's health protection. optimization of economic and social development organisation for evironmental impact reducing and human need satisfaction at clean and radiactive polluted territorias

Themes of practical lessons:

1. Ecological footprint analysis in different countries. Calculation of personal footprint/
2. Prediction of radionuclide accumulation in plants.
3. Decreasing of radionuclides accumulation in ecosystem components and human.
4. Modeling sustainable farm development
5. Material flow analysis at radionuclide polluted territories
6. Environmental management and innovation strategies for sustainable development
7. Analysis renewable energetics' development profits for sustainable development radionuclide polluted territories.

Readings:

1. Ecosystem health and sustainable agriculture/ Editor Christine Jakobson, Upsala University, 2012.
2. Environmental science. Upsala University, 2003.
3. Environment and sustainable development. Edited by M. Klavins, W.Leal Filho, J. Zaloksnis. Riga:Academic Press of University of Latvia, 2010.
4. to be filled further

METHODS OF SCIENTIFIC RESEARCH

Author: Aleh I. Rodzkin, Ph.D. (Biological Science), Associate professor
Total hours: 100
Lectures - 32
Seminars – 18
Self-study work - 62

Form of control: exam
Nr. of ECTS Credits: 2.5
Semester: 2
Course Level –1st year MA

Goals of the course – are forming the knowledge about methodology and principles of scientific research

Learning outcomes of the course

Professional/disciplinary skills:

To be able to:
- understand systemic approach in scientific research;
- apply knowledge in methods of conducting of interdisciplinary and radioecology scientific research;
- apply basic methods and instruments of research work;
- prepare scientific reports and present results of investigation.

Personal skills:
- to be able to communicate socialty;
- to be able to work in the team and be able for personal cooperation.

Short content:

1. Science as a basic form of knowledge in society. The role of science in the world. Science as a social institute and system of knowledge. The specification of research knowledge. The role of science for forming of personal skills.

2. The historical development of science. The history and basic stages of scientific research. Significance of science for society. The basic precondition for modern science. The development of research programs.

3. Methodological tools of science. Definition methods and methodology. Multilevel conception of knowledge. Basic methods and technique of scientific research. Object and subject of research work. The goal and tasks of research work. The basic methods of research work. Justification of the results of investigation.

4. Dialectical logic as methods of research knowledge. Formation and development of dialectical logic. The basic principles, legislation and rating of dialectical knowledge. Dialectic and historical approach. The methods of knowledge: from abstract to concrete.

5. Science as a social institute. Evolution of organizational forms of science. Science as a system of fundamental and applied research. Scientific research and experimental applied science. Science and education. Communications and its role in modern science. Polemic and discussion as forms of communications in research work. The culture and methods of discussion. Science and power, policy and ideology.

6. Science and technology. Evolution of technologies in modern society. The functions and role of technology. Technosphere, its development and basic principles. Globalization of technical systems. Nanotechnology and biotechnology. Informatization and computerization of science. Research discovery and invention.

7. Methods of scientific research. Theoretical and empirical methods of research. Induction and deduction, analysis and synthesis. Analytical methods. Statistical methods. Survey, measuring,

experiments. Modeling as a modern methods of research. Types of models and principles of modeling.

8. The choice and steps of research work. Scientific, applied and economic issues of research work. Criteria for assessment of results of research work. The basic steps of research work. The development of basic hypothesis and planning of research work. Collection and analysis of information. Reprocessing of dates. Introduction of results of research.

9. Search, collection and processing of dates. Kinds of research work. Informational and searching systems. International system for scientific and technical information. The basic principles of patent implementation. Methods os collection of research information. The methods of patent search and working with research sources.

10. Experiment. The purpose of experiments. Classification of experiments. Field, laboratory, industrial and other experiments. Methods of planning and implementation of experiments. Automatical systems of research work. Documentation of results of experiments. Methods of correction of mistakes and inaccuracy.

11. The processing of results of research work. The methods of mathematic statistic. Dispersion and correlation, mistakes and corrections. The methods of dispersion analyses. The methods of mathematic modeling. Conclusion and proposal as the results of scientific work.

12. Presentation and introduction of research work. The kinds of scientific reports. Contents of reports. Registration and legalization of results of research work. Registration of patents. The basic principles and methods of presentation. Theses and articles. The efficiency of research work. Indicators of research work. Introductions, kinds and rules of registration. The efficiency of research work.

13. Innovations. Goals and principles of innovation management. Life cycle assessment of products (technology). Innovational projects, principles and distinction. Classification of innovational products. Business plans. Basic principles and methods of development of business plans. Structure of business plan. The assessment of efficiency of business plans.

14. International aspects of research work. International research programmers and projects. International programmer's data base. Directions of cooperation with International scientific society. Opportunities for cooperation with International research institutes.

Themes of seminars:

1. Efficiency of research work. Examples and assessment.
2. Patents. History, principles, registration, profitable examples.
3. Methods of collection of information for research work: library, internet, questionnaire, etc.
4. Statistical methods of processing of information.
5. Preparation of applications for research grants
6. Research discussions (roles game)
7. Presentation of results of research work.
8. Actual problems for modern research work (roles game)
9. Sign in to the future. Research horizon and perspective.

Readings:
to be filled further

ENGLISH FOR ACADEMIC PURPOSES

Author: Natallia A. Gritsai, Senior Lecturer
Total hours: 100
Practical classes – 50
Self-study work - 50

Form of control: exam/final test- credit (see the plan)
Nr. of ECTS Credits: 2,5
Semester: 2
Course Level –1st year MA

Goals of the course –
- to develop the skills and techniques required by academic, scientific and social communication in a graded and systematic way;
- to stimulate activities such as answering questions, reflecting on difficult decisions, prioritizing options and completing charts;
- to develop students' awareness of the common problem areas.

Learning outcomes of the course
Professional/disciplinary skills:
- to develop their communication skills in the key scientific and business areas of presentations, meetings, negotiations, and social English;
- to understand attitude, detail, implication, main idea, opinion, purpose, specific information, text organisation features, tone and text structure;
- to write specialized and non-specialised text types such as an article, a contribution to a longer piece, an essay, information sheets, a letter, a proposal, a report, a review, or a competition entry, with a focus on advising, comparing, evaluating, expressing opinions, hypothesising, justifying and persuading;
- to focus on accuracy and knowledge of key areas of grammar;
- to develop students' readings skills and help to acquire essential vocabulary in the field of their professional interests and social, economic, political and cultural life;
- to show understanding of agreement, attitude, course of action, detail, feeling, function, gist, interpreting context, main points, opinion, purpose, specific information;
- to respond to questions and to interact in conversational English

Personal skills:
- to build up students' confidence in expressing their views in English and to improve their fluency;
- to encourage creative and imaginative solutions to the problems.

Short content:

1. Academic Readings. Paragraph Structure. The three parts of a paragraph. Unity and Coherence. The topic sentence. The concluding sentence. Unity and Outlining. The "Parallel Form" rule. The "Equivalent Value" rule. Coherence. Repetition of key nouns. Use of consistent pronouns. Transition signals. Types of transition signals. Logical order. Kinds of logical order. Chronological order. Transition signals for chronological order. Logical division of ideas. Transition signals for logical division of ideas. Order of importance. Transition signals for order of importance. Comparison\Contrast. Transition signals for comparison\contrast. Concrete Support. Examples. Extended examples. Statistics. Quotations. Paraphrases and summaries.

2. Academic Writing. Writing an essay\ scientific article. The introductory and concluding paragraphs. The Main Body. Transition signals between paragraphs. Organisation for chronological order. Organisation for logical division of ideas. Organisation for cause and effect order. Block organization with transition signals. Chain organization. Cause and effect structure words. Comparison and contrast order. Comparison structure vocabulary. Contrast structure vocabulary.

Sentence structure. Clauses: Independent and Dependent clauses. Clause connectors. Kinds of Sentences: Simple, Compound, Complex, and Compound-Complex Sentences. Parallelism. Sentence problems.Noun clauses. Adverbial clauses. Relative clauses. Punctuation.

3. Scientific\Academic Communication (Monologues and Dialogues).

4. Topics for Classroom Discussions: Society and Social Development. Work. Education, study and learning. Lifestyles, social and national customs. Business and Industry. Health and fitness. Biology and the body. The natural world and environment. Science and Technology.

Readings:

1. Fiona Scott-Barret, New Proficiency Use of English, Pearson Education Ltd, 2010
2. Oshima A., Hogue A., Writing Academic English, Addison Wesley Longman, 1999
3. Prodromou L., Grammar and Vocabulary for First Certificate, Pearson Education Ltd, 2008
4. Scientific articles

Conclusion

A Master graduates on a speciality "Radiobiology" essentially will differ from all specialties that exist nowadays because they combine deep medical and biologic preparation (as opposed to classical biologists and ecologists) and good ecological and toxicological, epidemiological, humanitarian and psychological preparation that allows to work in various fields of economy.

The sphere of professional work of a Master graduates is an industrial activity at the enterprises of light and food-processing industry; at factories, agricultural and other enterprises and establishments; carrying out experimental and research work at Scientific institutes; at branch and scientifically - research laboratories of medical and ecological profiles; carrying out analytical and supervising activity in the centers of hygiene and epidemiology (not medical posts); working out new methodical approaches in the field of medical and ecological control to provide the level of public health in various ecological situations.