PRACTICAL EXERCISES FOR THE COURSE OF RADIOLOGY IN FOOD INDUSTRY

Dr. József Prokisch associate professor

University of Debrecen

Faculty of Agricultural and Food Sciences, and Environmental Management

A Debreceni Egyetem fejlesztése a felsőfokú oktatás minőségének és hozzáférhetőségének együttes javítása érdekében
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Exercise 1. Natural radioactive isotopes, importance and applications

Purpose of the exercise:

To understand and discover the natural radioactive isotopes in our environment.

Required knowledge:

Necessary to understand the basics of nuclear science

Main task	Make a presentation about the natural radioactive isotopes in our environment. Show their origin and applications. Focus on the following isotopes: ^{3}H, ^{14}C, ^{40}K, ^{222}Rn, ^{232}Th, ^{235}U, ^{238}U, but you can select any other isotope which has special importance according to you.
Questions	What are the origin of this isotopes? Where they are? What is the concentration of them in different samples, especially in food? What is the fate of them? How can we measure them? What is the field and method of their application?
Recommended resources	^{3}H: https://en.wikipedia.org/wiki/Tritium https://nuclearsafety.gc.ca/eng/pdfs/Fact_Sheets/January-2013-Fact-Sheet-Tritium_e.pdf https://blog.banggood.com/what-are-tritium-viols-49803.html https://www.britannica.com/science/tritium http://www.buyersguidechem.com/AliefAus.php?pnumm=523807214680&gad=enEU ^{14}C: https://en.wikipedia.org/wiki/Carbon-14 https://www.solutions.bocsci.com/radiolabeled-chemical-synthesis.htm?gclid=Cj0KCQjwudb3BRC9ARIsAEa-vUvQjp0SCgfuLcl-obsVWNzkjLz92sdt7N8418kAo9pdHnEMOFkyYE8aAjJpEALw_wcB ^{40}K: https://en.wikipedia.org/wiki/Potassium-40 https://www.radioactivity.eu.com/site/pages/Potassium_40.htm ^{222}Rn: https://en.wikipedia.org/wiki/Radon-222

	^{232}Th: https://en.wikipedia.org/wiki/Isotopes_of_thorium ^{235}U, ^{238}U: https://en.wikipedia.org/wiki/Uranium others: https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_General_Chemistry_(Petrucci_et_al.)/25%3A_Nuclear_Chemistry/25.02%3A_Naturally_Occurring_Radioactive_Isotopes
Recommended videos	^{3}H: https://www.youtube.com/watch?v=xNU0uPiZB_Q https://www.youtube.com/watch?v=Ud6WCusQdm4 https://www.youtube.com/watch?v=cogRjF41HLA ^{14}C: https://www.youtube.com/watch?v=-xKvq6VLe4s ^{40}K: https://www.youtube.com/watch?v=ThwE0M-lAko ^{222}Rn: https://www.youtube.com/watch?v=tHoITOI1d8k ^{232}Th: https://www.youtube.com/watch?v=tHO1ebNxhVI ^{235}U, ^{238}U: https://www.youtube.com/watch?v=TSza2XH28hs https://www.youtube.com/watch?v=69UpMhUnEeY others: https://www.youtube.com/watch?v=mROgodnV2Bo https://www.youtube.com/watch?v=nnOFv8ojvMQ
Recommended articles, books	https://books.google.hu/books?id=zVrdAAAAQBAJ&printsec=frontcover&hl=hu&source=gbs_ge_summary_r&cad=0 https://www.sciencedirect.com/topics/earth-and-planetary-sciences/carbon-14 https://www.researchgate.net/publication/226963679_Determination_of_137Cs_90Sr_40K_radionuclides_in_food_grain_and_commercial_food_grain_products

	https://akjournals.com/view/journals/10967/269/2/article-p487.xml https://www.sciencedirect.com/science/article/pii/S1687850717300341 https://books.google.hu/books?id=T3efqvK-9iQC&printsec=frontcover&hl=hu&source=gbs_ge_summary_r&cad=0 https://books.google.hu/books?id=0BbNBQAAQBAJ&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary https://inis.iaea.org/collection/NCLCollectionStore/_Public/33/016/33016270.pdf https://books.google.hu/books?id=1mk3lFVtBSQC&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary http://www-naweb.iaea.org/napc/ih/documents/global_cycle/vol%20I/cht_i_08.pdf
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 2. Application of radioactive isotopes in the medical practice

Main task	Make a presentation about the application of radionuclides in the medical practice and research. Show examples for the preparation, storage and technics of isotopes. Show the basics of some technics for treatment and diagnostic like PET scan.
Questions	What are the purpose of application of radionuclides in the diagnostic and medical treatment? How you can produce the necessary radionuclides? What is the fate of this isotopes after the treatment?
Recommended resources	https://www.iaea.org/resources/rpop/health-professionals/nuclear-medicine https://www.iaea.org/sites/default/files/55405810507.pdf https://www.world-nuclear.org/information-library/non-power-nuclear-applications/radioisotopes-research/radioisotopes-in-medicine.aspx https://en.wikipedia.org/wiki/Nuclear_medicine https://www.adacap.com/nuclear-medicine/
Recommended videos	https://www.youtube.com/watch?v=PimbPIyLeZg https://www.youtube.com/watch?v=8YlABLzefKg https://www.youtube.com/watch?v=98zuh9S2L7o
Recommended articles	https://actavet.vfu.cz/media/pdf/avb_1999068040231.pdf https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1617web-1294055.pdf
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 3. Radioactive isotopes as contaminants in food

Main task	Make a presentation about the natural and anthropogenic radioactive isotopes in food.
Questions	What is the origin of these isotopes? Where they are? What is the concentration of them in different samples, especially in food? What is the fate of them? How can we measure them? What is the field and method of their application?
Recommended resources	https://www.who.int/publications/m/item/nuclear-accidents-and-radioactive-contamination-of-foods https://www.remm.nlm.gov/radmonitor_water_food.htm https://www.bfs.de/EN/topics/ion/environment/foodstuffs/introduction/introduction_node.html https://www.fda.gov/media/74043/download https://www.europarl.europa.eu/doceo/document/TA-8-2015-0267_EN.html#title2 http://www.fao.org/3/a-v3620e.pdf https://www-pub.iaea.org/MTCD/publications/PDF/trs295_web.pdf
Recommended videos	https://www.youtube.com/watch?v=vOjCo4UVDyk https://www.youtube.com/watch?v=a_SJH7VNAE0
Recommended articles	https://www.researchgate.net/publication/320716722_Radionuclides_in_Foods
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 4. Radioactive isotopes from the energetics and military origin

Main task	Make a presentation about the radioactive isotopes which has importance in the nuclear industry and in nuclear weapons.
Questions	Make a presentation about the isotopes what can be used in fusion and fission processes. Explain the origin and the fate of isotopes in the nuclear processes.
Recommended resources	^{3}H: https://en.wikipedia.org/wiki/Fusion_power https://www.iter.org/ https://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-fusion-power.aspx ^{235}U: https://en.wikipedia.org/wiki/Nuclear_fission https://en.wikipedia.org/wiki/Uranium-235 https://www.sciencedirect.com/topics/earth-and-planetary-sciences/uranium-235 ^{239}Pu https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/fuel-recycling/plutonium.aspx https://en.wikipedia.org/wiki/Reactor-grade_plutonium https://www.ipen.br/biblioteca/slr/cel/0562 ^{233}U https://en.wikipedia.org/wiki/Uranium-233 ^{233}Th https://www.sciencedirect.com/topics/medicine-and-dentistry/thorium https://books.google.hu/books?id=O0YB-T9usjIC&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary others: https://www.world-nuclear.org/information-library/non-power-nuclear-applications/radioisotopes-research/radioisotopes-in-industry.aspx
Recommended videos	https://www.youtube.com/watch?v=rEgjJsqYGIQ&pbjreload=101

	https://www.youtube.com/watch?v=XNcGpQCX8a0 https://www.youtube.com/watch?v=hl9-0orGOu4 https://www.youtube.com/watch?v=oAVCaUonrbE https://www.youtube.com/watch?v=YVSmf_qmkbg https://www.youtube.com/watch?v=B_XzYkdPfgk https://www.youtube.com/watch?v=RwHAQSKub7A https://www.youtube.com/watch?v=uYrhWO_ZLYw&t=469s https://www.youtube.com/watch?v=CYcesh3uHb4 https://www.youtube.com/watch?v=2g-yEXDJmew
Recommended articles	https://www.ieer.org/ensec/no-1/puuse.html
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 5. Type and sources of ionising radiations

Main task	Make a presentation about the type of radiations.
Questions	What type of ionizing radiations are known? What is the source of them and how can we make artificially the different radiations. What is the application of them? What is the effect of them on biological systems? What is the dose-effect relationship?
Recommended resources	https://en.wikipedia.org/wiki/Ionizing_radiation https://en.wikipedia.org/wiki/Alpha_particle https://en.wikipedia.org/wiki/Beta_decay https://en.wikipedia.org/wiki/Beta_particle https://en.wikipedia.org/wiki/Gamma_ray https://en.wikipedia.org/wiki/Neutron_radiation https://en.wikipedia.org/wiki/Cosmic_ray https://en.wikipedia.org/wiki/Particle_radiation https://www.britannica.com/science/radiation/Historical-background
Recommended videos	https://www.youtube.com/watch?v=iTb_KRG6LXo https://www.youtube.com/watch?v=wsspFQn0mWM https://www.youtube.com/watch?v=5CmT4PSrBmA https://www.youtube.com/watch?v=HfcX2vVIFd4 https://www.youtube.com/watch?v=io9nMX2CLq4 https://www.youtube.com/watch?v=qyWntl87HoQ https://www.youtube.com/watch?v=q-9Avd__dQ4 https://en.wikipedia.org/wiki/Neutrino
Recommended articles	https://www.thelancet.com/journals/a/article/PIIS1470-2045(09)70213-X/fulltext Environmental Protection Agency (2012). Radiation doses in perspective. http://epa.gov/radiation/understand/perspective.html Environmental Protection Agency (2012). Radiation protection: Health effects. http://www.epa.gov/radiation/understand/health_effects.html Environmental Protection Agency (2012). Radiation: Facts, Risks and Realities. http://www.epa.gov/radiation/docs/402-k-10-008.pdf

	Environmental Protection Agency (2012). Radiation: Non-ionizing and ionizing. http://epa.gov/radiation/understand/index.html Environmental Protection Agency (2012). Airport security scanning. http://www.epa.gov/radtown/security-scan.html Environmental Protection Agency (2012). Basic information. http://www.epa.gov/radtown/basic.html Environmental Protection Agency (2012). Sources of radiation exposure. http://epa.gov/radiation/sources/index.html
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 6. Nuclear accidents in the Soviet Union

Main task	Make a presentation on the nuclear accidents in the Soviet Union and Russia!
Questions	What was the reason and what were the consequences of the following accidents in the Soviet Union? Evaluate the following accidents! 1957 Mayak reprocessing plant, Ural-region Kyshtym disaster: Explosion in a waste tank of the plant with a massive radioactive cloud, deteriorating deeply the health of the regions population 26 Apr 1986 Pripyat, Ukraine, USSR Steam explosion and meltdown (Chernobyl disaster) August 10, 1985 Chazhma Bay, Vladivostok Release of nuclear materials About 35 miles (56 km) from Vladivostok in Chazhma Bay, the Soviet Echo-class submarine K-431 suffered a reactor explosion, producing fatally high levels of radiation. Ten men were killed, but the deadly cloud of radioactivity did not reach Vladivostok.
Recommended resources	List of every reported accidents are available here: https://en.wikipedia.org/wiki/List_of_nuclear_power_accidents_by_country https://en.wikipedia.org/wiki/List_of_military_nuclear_accidents Chernobyl: https://en.wikipedia.org/wiki/Chernobyl_disaster https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident.aspx https://www.nationalgeographic.com/culture/topics/reference/chernobyl-disaster/ https://www.iaea.org/newscenter/focus/chernobyl https://www.iaea.org/newscenter/news/30-years-after-chernobyl-iaea-continues-to-support-global-efforts-to-help-affected-regions Mayak: https://en.wikipedia.org/wiki/Kyshtym_disaster https://www.pierpaolomittica.com/stories/mayak-57/ Chazhma Bay:

	https://books.google.hu/books?id=Zi1mEX-6n0oC&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary https://clever-geek.github.io/articles/1140788/index.html https://inis.iaea.org/search/search.aspx?orig_q=RN:35090518 http://www.johnstonsarchive.net/nuclear/radevents/1985USSR1.html
Recommended videos	Chernobyl: https://www.youtube.com/watch?v=AZ4qOMN527s https://www.youtube.com/watch?v=KNEUd4DNE6I https://www.youtube.com/watch?v=Xw3SFOfbR84 https://www.youtube.com/watch?v=mdnutU2m71o https://www.youtube.com/watch?v=3KikK26mbyo https://www.youtube.com/watch?v=7YMf1NRByV8 https://www.youtube.com/watch?v=F2gnooj2xac https://www.youtube.com/watch?v=HlVV3pgH3ac Mayak: https://www.youtube.com/watch?v=V0uymbOYOgQ https://www.youtube.com/watch?v=-MVLYPkMlBA https://www.youtube.com/watch?v=Vn1DuMOuvHc https://www.youtube.com/watch?v=ElpZErmHvns Nuclear submarine accidents: https://www.youtube.com/watch?v=15TiAwuLmsk&t=354s https://www.youtube.com/watch?v=4jvQFoT9scg&t=16s https://www.youtube.com/watch?v=Y8cmgwe6I8k https://www.youtube.com/watch?v=ZTgbfRQAWrY
Recommended articles	https://www.nature.com/articles/359021a0.pdf https://inis.iaea.org/search/search.aspx?orig_q=RN:23059208 https://inis.iaea.org/search/search.aspx?orig_q=RN:18094611 https://www.sciencedirect.com/science/article/pii/S0936655511005425?casa_token=hHtXPos6-08AAAAA:Acv0nrXLnSBsbQj3uwZ1fo3gQ5CzvJDy6378HNtklPXUZhaDiIzWdIQ-GDrB0G092u-YzKni https://link.springer.com/content/pdf/10.1007/s11179-005-0046-1.pdf

	https://www.tandfonline.com/doi/abs/10.1080/18811248.2001.9715017 https://www.sciencedirect.com/science/article/pii/S0265931X00000874?casa_token=_tVs9lPFVbAAAAAA:S1CC_DoKHUkuRa5IuxMQGG2Wp6U_-TuQQbj2mo1_qHDCUV9cIEh8TcXn2NfXLwvMt49nKQoZ https://journals.lww.com/health-physics/Abstract/2007/09000/MAYAK_WORKER_DOSIMETRY_STUDY__AN_OVERVIEW.2.aspx
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 7. SL1 Nuclear accident case study

Main task	Evaluate the SL1 case: January 3, 1961. Idaho Falls, Idaho, USA Explosion at National Reactor Testing Station's SL-1 Stationary Low-Power Reactor Number One. The SL-1, or Stationary Low-Power Reactor Number One, was a United States Army experimental nuclear power reactor in the United States that underwent a steam explosion and meltdown on January 3, 1961, killing its three operators.
Questions	What happened and what caused the accident at the SL1 site of US Reactor Testing Station?
Recommended resources	https://en.wikipedia.org/wiki/SL-1
Recommended videos	https://www.youtube.com/watch?v=Q0zT9ARfsT4 https://www.youtube.com/watch?v=ryI4TTaA7qM https://www.youtube.com/watch?v=MiIaKIcmkKc https://www.youtube.com/watch?v=IYle_eI5j78
Recommended articles	https://journals.lww.com/health-physics/Abstract/1963/02000/The_Health_Physics_Aspects_of_the_SL_1_Accident.6.aspx https://www.tandfonline.com/doi/abs/10.13182/NT81-A32620?casa_token=m0pArxenF60AAAAA:poYOKRapEbbQpdvci7ImIy3LOrJTehos9szRT5fEfjAGw-OOF2D6BMET-5OnULkSOr24B_GnjAg
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 8. Tokaimura nuclear accident

Main task	Make a presentation about the Tokaimura radiation accident
Questions	What is happened? What was the reason of the critically accident? What happened with the victims?
Recommended resources	https://en.wikipedia.org/wiki/Tokaimura_nuclear_accident https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/tokaimura-criticality-accident.aspx
Recommended videos	https://www.youtube.com/watch?v=acpz3CG1xi4 https://www.youtube.com/watch?v=ZWomuWd7-to https://www.youtube.com/watch?v=vBOZ7d2eiEI
Recommended articles	https://www.sciencedirect.com/science/article/pii/004896978690152X https://academic.oup.com/cardiovascres/article/58/2/487/343469 https://www.birpublications.org/doi/abs/10.1259/bjr/82373369
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 9. Fukushima accident

Main task	Make a presentation about the Tokai Mura radiation accident
Questions	What is happened? What was the reason of the critically accident? What happened with the victims?
Recommended resources	http://171.67.100.116/courses/2017/ph241/kim-d1/docs/R41694.pdf https://books.google.hu/books?id=GW6i6pbzKgwC&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-daiichi-accident.aspx https://www.iaea.org/newscenter/focus/fukushima
Recommended videos	https://www.youtube.com/watch?v=-3GzQ9kryx4 https://www.youtube.com/watch?v=YBNFvZ6Vr2U https://www.youtube.com/watch?v=NewwV9wAmYI
Recommended articles	https://onlinelibrary.wiley.com/doi/full/10.1002/rob.21439?casa_token=9b9Xdr72LgsAAAAA%3AlcpqzSuNgc-15p4un3xKC7X2Uv-_vRhuoUxPhfrRKtLioOSyTkP72_--vk7m9nSaemznJMR-fWNvPA https://www.liebertpub.com/doi/abs/10.1089/thy.2015.0564 https://science.sciencemag.org/content/336/6085/1115.summary?casa_token=QSWbBwht6LkAAAAA:SC9U82COw6KDnL8getBhPwoz7_Bncgy7WH_kPMqio1wuIt4QSgzxdGDVjENfUi6ZlD2gwYMIrrjw https://www.nature.com/articles/srep16976/ https://www.sciencedirect.com/science/article/pii/S004896971301173X?casa_token=vKXgD6pFyCIAAAAA:hcrX5_4EPG6hnYlRcp0xK3G32Ce30qgx3wc8PbqN-dsTlMtGJ7PqEuL1ufOH2WBaSWfMp73s https://pubs.acs.org/doi/suppl/10.1021/es202816c/suppl_file/es202816c_si_001.pdf
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 10. Historical role of Hungarians in the nuclear industry

Main task	Hungarian researchers had fundamental role in the nuclear science in the US. Find the most well-known Hungarian scientist and present their role in the history of nuclear science.
Questions	What was the main results and role in the nuclear science of the following Hungarian scientist:  Theodore von Kármán,  John von Neumann,  Leó Szilárd,  Edward Teller and  Eugene Wigner All five were from Budapest. They all attended its excellent high school, went to its technical university, completed their studies in Germany and eventually immigrated to America. Von Kármán, the eldest, was born in 1881, Szilárd in 1898, Wigner in 1902, von Neumann in 1903 and Teller in 1908. All were raised in middle-class, highly intellectual Jewish households. In the years after the First World War there was a dramatic increase in anti-Semitism in Hungary. With the exception of Teller's, their families converted to Christianity, which offered them some protection until the rise of Nazism in the 1930s, when converted Jews were rudely

	reminded of their origins. By the early 1930s, all five men were well known in America.
Recommended resources	https://en.wikipedia.org/wiki/Theodore_von_K%C3%A1rm%C3%A1n https://en.wikipedia.org/wiki/John_von_Neumann https://en.wikipedia.org/wiki/Leo_Szilard https://en.wikipedia.org/wiki/Edward_Teller https://en.wikipedia.org/wiki/Eugene_Wigner "The Martians" was a term used to refer to a group of prominent Hungarian scientists (mostly, but not exclusively, physicists and mathematicians) who immigrated to the United States in the early half of the 20th century. Paul Erdős, Paul Halmos, Theodore von Kármán, John G. Kemeny, John von Neumann, George Pólya, Leó Szilárd, Edward Teller, and Eugene Wigner are included in this group. Dennis Gabor, Ervin Bauer, Róbert Bárány, George de Hevesy, Nicholas Kurti, George Klein, Eva Klein, Michael Polanyi and Marcel Riesz are also sometimes named, though they did not immigrate to the United States. Loránd Eötvös, Kálmán Tihanyi, Zoltán Lajos Bay, Victor Szebehely, Albert Szent-Györgyi, Georg von Békésy and Maria Telkes are often mentioned in connection. Elizabeth Róna, a Hungarian nuclear chemist who immigrated to the US in 1941 to work on the Manhattan Project and discovered Uranium-Y, is not often included. https://en.wikipedia.org/wiki/The_Martians_(scientists)
Recommended videos	Theodore von Kármán, https://www.youtube.com/watch?v=eulkTOfGNwM https://www.youtube.com/watch?v=-blMxK8TX0Q https://www.youtube.com/watch?v=tSP5cpTvWBc John von Neumann, https://www.youtube.com/watch?v=97hfRcrYBtE https://www.youtube.com/watch?v=fJltiCjPeMA https://www.youtube.com/watch?v=Ml3-kVYLNr8 https://www.youtube.com/watch?v=Y2jiQXI6nrE https://www.youtube.com/watch?v=vLbllFHBQM4 Leó Szilárd,

	https://www.youtube.com/watch?v=SVIIFBHhl6g&t=1327s https://www.youtube.com/watch?v=OgT-Gw6Pjz4 https://www.youtube.com/watch?v=PCWRPMZCFww Edward Teller, https://www.youtube.com/watch?v=z8uZKs0Pv68 https://www.youtube.com/watch?v=mfN12mTtT7c https://www.youtube.com/watch?v=4_oGLN0p3Gc https://www.youtube.com/watch?v=ra4K6WPUkpk Eugene Wigner https://www.youtube.com/watch?v=lZZXX9r-ALw https://www.youtube.com/watch?v=iYLS2SUvWTs
Recommended articles	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1079162/ https://books.google.hu/books?id=Wh4nAgAAQBAJ&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary https://books.google.hu/books?id=AcAjDwAAQBAJ&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary https://books.google.hu/books?id=r_NjDwAAQBAJ&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary
Outcome of exercise	Make a presentation which show the role of Hungarian scientist in the history of nuclear science!

Exercise 11. Legislations related to food radiation

Main task	Because of the health risk of radiation and radioactive isotopes the regulations must be strict and well established. The control and checking must be well organised. Collect the regulations related to the food radiation. It has high importance and significance especially in the case of radiation accidents or other contamination case. Environmental radioactivity monitoring in EU happens according to the obligation under EURATOM Treaty Art. 35 + 36. It is dealing with mainly anthropogenic radionuclides (e.g. Cs-137, I-131 and Sr-90). It is a realistic and reliable internal doses estimation – by activity concentrations measurements. It deal with the monitoring of food and feed – as an important part of the environmental monitoring. There is an environmental monitoring information exchange networks in the EU: EURDEP – European Radiological Data Exchange Platform – – automatic monitoring data exchange; > 4400 stations in 35 European countries EURDEP → IAEA for monitoring at worldwide level (IRMIS) ECURIE – EC Early Notification and Urgent Information Exchange network – better preparedness and response to trans-boundary events ENSEMBLE – harmonisation and coherence of emergency management and decision-making in relation to long range atmospheric dispersion modelling DG JRC DG SANCO RASFF – the Rapid Alert System for Food and Feed crossing borders Legislations related to the food: Council Regulation (Euratom) No 3954/87 Laying down maximum permitted levels of radioactive contamination of foodstuffs and of feeding stuffs following a nuclear accident or any other case of radiological emergency. Commission Regulation (Euratom) No 944/89 Laying down maximum permitted levels of radioactive contamination in minor foodstuffs following a nuclear accident or any other case of radiological emergency. Council Regulation (Euratom) No 2218/89 Amending Regulation (Euratom) No 3954/87 laying down maximum permitted levels of radioactive contamination of foodstuffs and of feeding stuffs

	following a nuclear accident or any other case of radiological emergency. Council Regulation (EEC) No 2219/89 On the special conditions for exporting foodstuffs and feeding stuffs following a nuclear accident or any other case of radiological emergency. Commission Regulation (Euratom) No 770/90 Laying down maximum permitted levels of radioactive contamination of feeding stuffs following a nuclear accident or any other case of radiological emergency. EU Legislation in the field of food monitoring **Import of foodstuff from Japan after Fukushima nuclear accident** Commission Implementing Regulation (EU) No 322/2014 Imposing special conditions governing the import of feed and food originating in or consigned from Japan following the accident at the Fukushima nuclear power station. **Chernobyl affected areas** Council Regulation (EEC) No 737/90 On the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power-station. Council Regulation (EC) No 616/2000 Amending Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station. Commission Regulation (EC) No 1609/2000 Establishing a list of products excluded from the application of Council Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station. Commission Recommendation (EC) No 274/2003 On the protection and information of the public with regard to exposure resulting from the continued radioactive caesium contamination of certain wild food products as a consequence of the accident at the Chernobyl nuclear power station. Commission Regulation (EC) No 1635/2006 Laying down detailed rules for the application of Council Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power-station. Council Regulation (EC) No 733/2008 On the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station. Council Regulation (EC) No 1048/2009 Amending Regulation (EC) No 733/2008 on the conditions governing imports of

	agricultural products originating in third countries following the accident at the Chernobyl nuclear power station.
Questions	What are the radiation limits in Europe and in the US for the food? What is the background and what are the values in different case stories?
Recommended resources	https://europa.eu/european-union/sites/europaeu/files/docs/body/consolidated_version_of_the_treaty_establishing_the_european_atomic_energy_community_en.pdf https://www.fsai.ie/legislation/food_legislation/contamination_of_foodstuffs/radioactive_contamination.html http://www.legislation.gov.uk/ukdsi/2019/9780111180228/pdfs/ukdsi_9780111180228_en.pdf https://www.food.gov.uk/safety-hygiene/radioactivity-in-food https://www.epa.gov/radiation/what-federal-standards-address-radioactivity-food https://www.fda.gov/media/72014/download https://www.epa.gov/radiation/radiation-regulations-and-laws https://eurdep.jrc.ec.europa.eu/Entry/Default.aspx
Recommended videos	https://www.youtube.com/watch?v=EHykLjGyE2A https://www.youtube.com/watch?v=Lnd22Bdoayw https://www.youtube.com/watch?v=gPJfwivvSQs https://www.youtube.com/watch?v=v8wKbpsw-OE https://www.youtube.com/watch?v=BIKro3s6eU4 https://www.youtube.com/watch?v=Orh4AFUCV98 https://www.youtube.com/watch?v=EbpBqnMHqqY
Recommended articles	https://ec.europa.eu/jrc/en/publication/european-union-radiological-data-exchange-platform-eurdep-25-years-monitoring-data-exchange https://www.jstor.org/stable/24109727 https://www.sciencedirect.com/science/article/pii/0265931X8790004X

	https://www.sciencedirect.com/science/article/pii/0265931X9290023M https://www.sciencedirect.com/science/article/pii/0168900290908665 https://inis.iaea.org/search/search.aspx?orig_q=RN:13671482
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 12. Treatment of food with gamma radiation

Main task	Gamma radiation is a special technology for increasing the shelf life of food by killing of microorganism by gamma radiation. Food irradiation is a process in which food products are exposed to a controlled amount of radiant energy to increase the safety of the food and to extend shelf life of the food. Like pasteurization of milk and pressure cooking of canned foods, treating food with ionizing radiation can kill bacteria and parasites that would otherwise cause foodborne disease. Irradiation is physical treatment of food with high-energy ionising radiation to: Destroy micro-organisms, viruses, bacteria or insects Prevent germination and sprouting of potatoes, onions and garlic Slow down ripening and ageing of fruit and vegetables Prolong the shelf life and prevent food-borne diseases in meat, poultry and seafood Its use is limited but authorised in many countries. When is food irradiation authorised? Treating food with ionising radiation may be authorised if: there is reasonable technological need it poses no health hazard it benefits consumers it does not replace hygiene, health or good manufacturing or agricultural practice Irradiated food or one containing irradiated ingredients must be labelled. Food irradiation has nothing to do with radioactive contamination of food resulting from a spill or an accident. Food is packed in containers and moved by conveyer belt into a shielded room. Food is exposed briefly to a radiant-energy source. (The amount of energy depends on the food.) Food is left virtually unchanged, but the number of harmful bacteria, parasites and fungi is reduced and may be eliminated. The safety and efficacy of food irradiation, as demonstrated by numerous experiments and studies, is widely accepted by Federal regulatory agencies and national and international food and public health organizations

	FDA examined numerous studies on the chemical effects of radiation, the impact of radiation on nutrient content of foods, potential toxicity concerns and effects on microorganisms in or on irradiated products. FDA concluded that irradiation is safe in reducing disease-causing microbes in or on meat food products and it does not compromise the nutritional quality of treated products. The World Health Organization, Food and Agriculture Organization, American Medical Association and American Dietetic Association endorse food irradiation Introduction to technology The irradiation device consists of a radiation source (2 sheet sources), the surrounding biological protection, and the material transport device moving the product to be treated next to the radiation source, the radiation protection locking system and the control device coordinating the operation of the former. The equipment also includes loading bays, engine room and other service rooms. The radiation source is ^{60}Co artificial radioisotope. The radioactive isotope cobal-60 is produced by irradiation of a naturally shaped cobalt-59 a in a nuclear reactor in a suitable form by a (n, gamma) nuclear reaction. The metal cobalt elements are cylinders and lozenges 5 - 8 mm in diameter, a few mm thick (5 - 20 mm). The lozenges are placed in a stainless steel case and sealed airtight, creating elemental sources. In a new stainless steel case, hermetically sealed in a new stainless steel case. "pencils" are formed During their decay, the ^{60}Co atoms emit a gamma photon with energies of 1.17 and 1.33 MeV in the form of electromagnetic radiation. This radiation, when passing through the stainless steel enclosure, also penetrates the material to be treated, while causing physical, chemical and, ultimately, biological changes as a result. The goal of treatment is always to achieve a specific biological change that can be achieved by communicating a sufficient amount of energy and this energy absorbed by the product is called the absorbed dose. The absorbed dose depends on the activity of the radiation source, the so-called source-product geometry, the density of the product and the time of treatment. The source activity decreases according to an exponential function that can be described mathematically accurately in proportion to the decay of the atomic shell. The geometry of the source product is constant

	for the respective plant, so the treatment dose can be adjusted with the irradiation time depending on the density.
Questions	What is the technology of food irradiation? What are the advantages and disadvantages of the method? What is the regulation for gamma radiation of food? How can we detect the radiated food?
Recommended resources	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31999L0002 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:31999L0002&from=EN https://www.fsai.ie/uploadedFiles/Dir1999_2.pdf https://www.fsai.ie/uploadedFiles/Dir1999_3.pdf https://www.food.gov.uk/safety-hygiene/irradiated-food https://books.google.hu/books?id=c3os1QZ2ic0C&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary https://www.globalharmonization.net/sites/default/files/pdf/GHI-Food-Irradiation_October-2018.pdf https://en.wikipedia.org/wiki/Food_irradiation https://www.fda.gov/food/buy-store-serve-safe-food/food-irradiation-what-you-need-know
Recommended videos	https://www.youtube.com/watch?v=_9vwS3_s1b4 https://www.youtube.com/watch?v=pe6AKh_tLys https://www.youtube.com/watch?v=2MJc_WNl7ME https://www.youtube.com/watch?v=2MJc_WNl7ME
Recommended articles	https://books.google.hu/books?id=3V5IndKfswEC&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary https://www.sciencedirect.com/science/article/pii/S0924224410001044?casa_token=51GOG8DvoV0AAAAA:hbKY77rKDZJt7AdH5HxdBZjn--aZDaXevIqWGyEzJffw8Nq66IiVJ-yb8Yn0OQD7Ps9FPMS7 https://www.sciencedirect.com/science/article/pii/S0969806X01006223?casa_token=cFnbKTV0F5YAAAAA:GTh6O0Gp7wRSPo2M_ESESoSByxChVpdgVvr_2MNKkEUhVARa5OFmIpyOIXBDcBvRfAspd-xQ https://www.sciencedirect.com/science/article/pii/S0969806X0800248X?casa_token=5P7g0aQGjXsAAAAA:KE1tYQhi1aiFtLv

	F_OGujw-2HVGzHTf75K1TGti8AGj4kLQzp-tynFGfzl-8MpPN4y3OOnMq https://books.google.hu/books?id=LT6JhC2zdocC&hl=hu&source=gbs_slider_cls_metadata_0_mylibrary
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!

Exercise 13. Creative challenge: *how could you use the nuclear energy*

Main task	Many young amateur guy tried to make nuclear reactor or nuclear tools at home. Make a study on different case. Evaluate the opportunities, consequences and risk.
Questions	Was there any successful attempt or all ended with an FBI case? What can we learn form these cases?
Recommended resources	https://en.wikipedia.org/wiki/David_Hahn https://arstechnica.com/tech-policy/2017/03/radioactive-boy-scout-died-of-alcohol-poisoning-not-radiation-father-says/ https://www.popularmechanics.com/science/a30917842/homemade-nuclear-reactor/ https://www.instructables.com/id/Build-A-Fusion-Reactor/ https://www.nationalgeographic.com/news/2015/07/150726-nuclear-reactor-fusion-science-kid-ngbooktalk/ https://interestingengineering.com/new-zealand-student-selling-homemade-nuclear-fusion-reactor-on-trademe https://en.wikipedia.org/wiki/Nuclear_reactor https://www.bbc.com/future/article/20200309-are-small-nuclear-power-plants-safe-and-efficient https://www.businessinsider.com/12-year-old-builds-nuclear-reactor-at-home-with-equipment-from-ebay-2019-4 https://fusor.net/board/viewtopic.php?f=18&t=12120
Recommended videos	https://www.youtube.com/watch?v=lV28dOGC_ps https://www.youtube.com/watch?v=5HL1BEC024g https://www.youtube.com/watch?v=x1bpTCt2vgk https://www.youtube.com/watch?v=t5wntLZCcYA https://www.youtube.com/watch?v=tvNSyH--MjI https://www.youtube.com/watch?v=k6j7wksLhaw https://www.youtube.com/results?search_query=Taylor+Wilson+ted https://www.youtube.com/watch?v=-tAsHGFA-74 https://www.bbc.com/news/10385853

Recommended articles	https://www.sciencedirect.com/science/article/pii/S1876610219312834 https://www.sciencedirect.com/science/article/pii/S0149197008000851
Outcome of exercise	Make a discussion forum about the possibility of the future of home size reactors. How can you built a car, boat or airplane with nuclear energy?

Exercise 14. National and international organisations related to the nuclear industry

Main task	Make a presentation about the international organisations of nuclear industry and science! Here is a list about the most important organisations all over the world: American Nuclear Society United States Atomic Energy Commission of India India Atomic Energy of Canada Limited Canada British EnergyUnited Kingdom Canadian Nuclear Safety Commission Canada Egyptian Atomic Energy Authority Egypt Électricité de France France Environmentalists for Nuclear Energy France Environmentalists for Nuclear Energy Australia Australia EURATOM Europe Federal Atomic Energy Agency Russia Institute of Nuclear Power Operations United States International Atomic Energy Agency (IAEA) International (headquarters in Vienna, Austria) National Atomic Energy Commission (CNEA) Argentina Nuclear Energy Corporation of South Africa (NECSA) South Africa Nuclear Energy Institute United States Nuclear Industry AssociationUnited Kingdom Pakistan Atomic Energy Commission Pakistan Pakistan Nuclear Society Pakistan Russian Federal Atomic Energy Agency Russia United Kingdom Atomic Energy Authority United Kingdom United States Department of Energy United States World Nuclear Association (WNA) International The organisations offer scholarships for students and researchers. Make a search for the actually available possibilities!
Questions	What are the main organisations, what is the role of them? What is the history of them?

Recommended resources	https://www.ans.org/ http://www.dae.gov.in/node/394 https://www.aecl.ca/ https://www.edfenergy.com/ https://www.cnsc-ccsn.gc.ca/ https://www.irdp-online.org/egyptian-atomic-energy-commission https://www.edf.fr/ http://ecolo.org/ https://www.efn.org.au/ https://www.instituteforgovernment.org.uk/explainers/euratom https://fas.org/nuke/guide/russia/agency/minatom.htm http://www.inpo.info/ https://www.iaea.org/ http://www.necsa.co.za https://www.nei.org/home http://www.paec.gov.pk/ https://www.world-nuclear.org/ https://ec.europa.eu/jrc/en/about/jrc-site/geel
Recommended videos	https://www.youtube.com/watch?v=9TmYGBtmSk4 https://www.youtube.com/watch?v=qa9IaSuPumA https://www.youtube.com/watch?v=H8sOx3K0SuI https://www.youtube.com/watch?v=ZP2N4PozmVk
Recommended articles	https://inis.iaea.org/search/search.aspx?orig_q=RN:27021328 https://www.imeko.org/publications/tc11-2011/IMEKO-TC11-2011-03.pdf https://www.epj-conferences.org/articles/epjconf/abs/2016/01/epjconf-ISRD2015_04002/epjconf-ISRD2015_04002.html
Outcome of exercise	Make a presentation which gives answer for the questions and explain the importance of the topic!