**November 2020**

1. Beta-decay (especially WHY, in Beta-Minus decay, does the neutron convert to proton + electron + antineutrino --> we looked into the standard model (bosons, fermions, which hadrons are that (baryons are fermions, mesons are bosons --> quarks constellation), opposite of hadrons are leptons --> which categories apply for the particles in beta decay (p, n, e are fermions, and thus matter particles, whereas photons, like gluons and are exchange particles for the fundamental interactions, thus force particles and bosons) --> the standard model was asked in more detail whereas the fundamental forces were only mentioned and slightly discussed (would have been the
2. ) question if we hadn't already discussed it.)
3. dose units: pretty much all there are (physical and biological), at least know what KERMA is and know that the dose rate (dependece of dose unit from time) is important for measuring them when you walk into a room;  
   then how do you get to the biological units, how do you convert Gray to Sievert, what does the radiation weighting factor depend on (type of radiation AND energy), what does the tissue weighting factor depend on, what is the highest (alpha-particle with 20), where does it come from (RBE).
4. differential energy loss: dE/dx --> more in the direction of LET than Bethe-Weizsäcker-equation, but very detailed as well (like how does it depend on velocity -->E is proportional to 1/v^2 I think --> therefore the energy gets smaller with higher velocity, but once the velocity is really high there are relativistic effects (lenght contraction) and the energy rises once again)
5. PET: know that this is about measuring metabolism in certain regions --> positrons are given to the patient and interact with glucose (sugar) --> positron + electron annihilate and create two photons in the oppsosite direction (positron is resting and has no impulse, therefore we need two photons to have their impulses cancel each others out --> momentum conservation) --> also know that the measurement is called 'coincidence measurement')
6. Proton vs Photon Therapy --> know the graph (in one of the last slides) and that you can change the energy of the proton and thus the bragg peak to irradiate the whole tumor region, whereas the photon region can't be changed like that
7. Cyclotron: know what it looks like --> two half moon shaped electrodes that are empty inside (--> Faraday shield, therefore no E-field, but just B-field inside), alternating voltage is applied, source is in the centre --> beam only accelerates in the gap between the electrodes (since there is the E-field) and follows circular motion inside the electrodes (due to the B-field) --> hence it is about Lorentz force (He then stopped there since I knew everything)
8. RIA: know in principle whether a deficit or excess of antibody is added (RIA vs IMRA), what you want to measure (immun reaction via finding the antigens (which cause the body to react and produce antibodies that bind and neutralize those antigens) --> for this method we have to know which antigen we are looking for, then apply the fitting antibodies and further radioactive antigens of the same kind and measure the antibodies in the liquid;  
   also know how the calibration curve comes in place and that at first we don't have any antigen, which causes high activity as all radioactive antigens bind to the antibodies, and then we slowly place more 'normal' antigens into it to create the full curve

**20.11.2019**  
6 pages, 6 points each.  
  
Alpha, beta, gamma decay  
A few short questions regarding biological effects (e.g. water radicals, stochastic and deterministic effects, somatic mutations, ...)  
Oxygen effect and relationship with LET  
PET - principle and sketch  
IMRA - principle and sketch  
Cyclotron - principle and sketch

**November 2020 Mündlich**

* Vier fundamentale Wechselwirkungen; über welche Reichweiten wirken sie, wie stark sind sie relativ zueinander, durch welche Teilchen werden sie vermittelt.
* Röntgenstrahlung: Wie entsteht sie, welche Arten gibt es
* Alphazerfall: was ist so besonders (Größenordnungen der Halbwertszeiten!), wie funktioniert das mit dem Tunneleffekt
* Dosiseinheiten: Exposure, Dose, Kerma, Äquivalenzdosis, Effektive Dosis
* Cyclotron: Funktionsweise, wie kann man die Energie der beschleunigten Teilchen ändern
* PET: wichtig war, dass die Photonen als Signal gezählt werden, die gleichzeitig (coincidence measurement) auftreffen
* Radiochemie von Wasser: LET, OER, Radikale, Sauerstoffeffekt, Warum sieht der Graph der OER über LET so aus, wie er aussieht (steht auf den modified slides)
* RIA und IRMA: bei RIA bedeutet hohe Aktivität, dass wenig Antigene in der Flüssigkeit waren; bei IRMA ist es genau anders herum! Wichtig sind auch die Kalibrierungskurven
* Differentieller Energieverlust; welche Größen tauchen in der Bethe-Bloch-Formel auf (diese nicht explizit gefragt), warum steigt der Energieverlust wieder bei hohen Geschwindigkeiten

Bis auf die Röntgenstrahlung, die Dosiseinheiten und die 4 WW ist alles mehrfach vorgekommen, das gibt vielleicht ein gutes Bild, was dem Prof. Badurek wichtig ist – und es deckt sich ja auch mit dem Bericht vom letzten Mal.

**My 35 min oral exam contained:**

* 4 fundamental forces
* beta decay, free neutron lifetime
* alpha decay & tunneling
* RIA
* OER & water radicals
* Bethe Bloch formula (factors, not exact) & LET, photon vs proton energy transfer diagram
* cyclotoron, here he stressed, that you cannot vary the energy, since it has to run on full energy already, change only in synchrotron.

Altogether almost the same as my previous poster, same focus as well if not mentioned differently. He is very nice and helps over difficulties, but does ask some deeper questions to test your insight.

**From FB:**

- what is a radical and how its formed

- bending energy of the nucleus

- alpha and beta radiation

- and curves are important to study.

PET, what is a radical, Water radicals, IRA, cyclotron, oxygen effect

**13.12.22**

6 questions with sub questions

- IRMA (explain&sketch)

- relationship OER/LET (sketch & explain)

- oxygen effect

- somatic mutations

- sketch binding energy per nucleon -> fusion fission

- Cyclotron

- photoelectric effect & pair production (explain & sketch)

- photon vs ion therapy (explain & sketch)

- why can photon not be absorbed by free electron (-> energy & momentum conservation)

- effect of LET on cell survival