

## Kratek opis usposabljanja mladega raziskovalca (*Short description of the Young Researcher's training*)

1. Raziskovalna organizacija (*Research organisation*):

Univerza v Ljubljani, Biotehniška fakulteta

2. Ime, priimek in elektronski naslov mentorja (*Mentor's name, surname and email*):

Polonca Štefanič, polonca.stefanic@bf.uni-lj.si

3. Šifra in naziv raziskovalnega področja (*Research field*):

4.06.04 Mikrobna biotehnologija / 4.06.04 Microbe biotechnology

4. Kratek opis usposabljanja mladega raziskovalca (*Short description of the Young Researcher's training*):

Navedite tudi morebitne druge zahteve, vezane na usposabljanje mladega raziskovalca (npr. znanje tujih jezikov, izkušnje z laboratorijskim delom, potrebne licence za usposabljanje...).

*slo:*

### OPIS DELA IN PROGRAM USPOSABLJANJA

Program usposabljanja mladega raziskovalca bo vezan na proučevanje interakcij in vpliva le-teh na horizontalni prenos genov (HGT) med bakterijami rodu *Bacillus*, ki jih na Katedri za mikrobiologijo, Biotehniške fakultete, Univerze v Ljubljani dobro obvladujemo na molekularnem nivoju. Na voljo imamo znanje in ustrezne seve ter genske konstrukte, ki omogočajo natančno proučevanje molekularnih mehanizmov vzpostavljanja mikrobnih interakcij med bolj in manj sorodnimi sevi rodu *Bacillus*. Tekom usposabljanja bo mladi raziskovalec poleg metod sledenja interakcij osvojil metode bioinformatike za proučevanje diverzitete bakterij rodu *Bacillus* na nivoju filogenije in proteomike, proizvodnje sekundarnih metabolitov, fagov in drugih mobilnih genskih elementov. S slednjimi bo na osnovi arhiviranih in eksperimentalno zbranih sekvenc genomov *Bacillus* ovrednotil dinamiko prenosa genov znotraj vrst in med različnimi vrstami rodu *Bacillus*. Program usposabljanja mladega raziskovalca bo razdeljen na tri večje sklope: (i) vpliv sorodnosti donorske DNA in sprejemnega bakterijskega kromosoma na sprejem in vgradnjo DNA znotraj vrste *B. subtilis* in rodu *Bacillus* (ii) vpliv bakterijskih interakcij na prenos genov znotraj vrste *B. subtilis* in znotraj rodu *Bacillus*, (iii) bioinformatična analiza genomov pridobljenih iz podatkovnih baz in eksperimentalno pridobljenih genomskih sekvenc sevov rodu *Bacillus*. Za proučevanje vpliva sorodnosti donorske DNA in sprejemnega kromosoma na sprejem in vgradnjo DNA bomo merili frekvenco transformacije kompetentnih sevov, katerim bomo dodajali DNA pridobljeno iz različno sorodnih sevov rodu *Bacillus*. Vpliv interakcij na prenos DNA bomo proučevali na poltrdnem agarškem gojišču, na katere bomo nacepili različno sorodne seve *Bacillus* in preko merjenja frekvence transformacije med interakcijo merili stopnjo prenosa genov med sevi. Pridobljene ekperimentalne rezultate prenosa genov v *in vitro* pogojih bomo primerjali z bioinformatičnimi analizami genomov, kjer bomo ovrednotili sestave genomov različnih sevov rodu *Bacillus*. Poleg bioinformatike bo kandidat pridobil tudi znanja iz gojenja mikroorganizmov, molekularne mikrobiologije in priprave rekombinantnih sevov, izolacije in analize DNA, določanje

frekvence horizontalnega prenosa genov, odziva celic na ta prenos in vpliva medceličnih interakcij (kooperativnih/antagonističnih) na HGT prenos. Program usposabljanja temelji na novih raziskovalnih pristopih, ki od kandidata za mladega raziskovalca zahtevajo osnovna znanja iz mikrobiologije, molekularne biologije in bioinformatike. Rezultati raziskovalnega programa bodo po pričakovanjih dali odgovore na vprašanja, ki se dotikajo znotrajvrstnega in medvrstnega horizontalnega prenosa genov in bodo dodatno poglobili poznavanje dinamike genskega prenosa za katerega obstaja več ne-izključujočih hipotez (vpliv socialnih interakcij, seksualna izolacija).

#### ŽELJENE LASTNOSTI/PREDZNANJA

1. Končan univerzitetni študijski program druge stopnje oz. kot določa nacionalna zakonodaja in sicer iz smeri, biologije, biokemije, biotehnologije, mikrobiologije, ali druge naravoslovne smeri s čim boljšimi predznanji bioinformatike, oziroma pripravljenost na dodatno izobraževanje na področju mikrobiologije za magistrante bioinformatike.
2. Zaželjeno znanje bioinformatike (Python, programski jezik R in podobno)
3. Želja po izobraževanju doma in po potrebi v tujini, predstavljanje raziskav na domačih in mednarodnih konferencah.
4. Odlično znanje slovenskega in angleškega jezika (pisno in pogovorno),
5. Vozniški izpit B kategorije
6. Samostojnost pri učenju in delu, a obenem zmožnost delovanja v večji skupini,
7. Prednost je, če ima kandidat izkušnje pri raziskovalnem delu in tudi pisanju izvirnih znanstvenih del v slovenskem in angleškem jeziku.

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#### JOB DESCRIPTION AND TRAINING PROGRAMME

The training programme for the young researcher will be related to the study of cell-cell interactions and their influence on gene transfer between bacteria of the genus *Bacillus*, which are well recognised at the molecular level at the Chair of Microbiology, Biotechnical Faculty, University of Ljubljana. We have the knowledge and appropriate strains and genetic constructs that allow a detailed study of the molecular mechanisms of microbial interactions between more and less related strains of the genus *Bacillus*. During the training, in addition to interaction tracking methods, the young researcher will master bioinformatics methods to study the diversity of bacteria of the genus *Bacillus* at the level of phylogeny and proteomics, production of secondary metabolites, phages and other mobile gene elements. Using the latter, he/she will assess the dynamics of gene transfer within *B. subtilis* species and between different species of the genus *Bacillus*, using both database deposited and experimentally collected sequences of *Bacillus* genomes. The training programme for the young researcher will be divided into three main parts: (i) the influence of relatedness of donor DNA and the receiving bacterial chromosome on DNA uptake and incorporation within *B. subtilis* and the genus *Bacillus*, (ii) the influence of bacterial interactions on gene transfer within *B. subtilis* and within the genus *Bacillus*, (iii) bioinformatic analysis of genomes from databases and experimentally collected genomic sequences of strains of the genus *Bacillus*. To investigate the effect of relatedness of the donor DNA and the recipient chromosome on DNA uptake and integration, we will measure the transformation frequency of competent strains to which we add DNA obtained from differentially related strains of the genus *Bacillus*. The effect of interactions on DNA transfer will be studied on semi-solid agar medium to which differentially related *Bacillus* strains are inoculated, and the rate of gene transfer between strains will be measured by measuring the

transformation frequency during the interaction. The obtained experimental results of gene transfer under in vitro conditions will be compared with bioinformatic genome analyses, where we will evaluate the compositions of the genomes of different strains of the genus *Bacillus*. In addition to bioinformatics, the candidate will gain knowledge in microorganism cultivation, molecular microbiology and preparation of recombinant strains, DNA isolation and analysis, determination of horizontal gene transfer frequency, cell response to this transfer and the influence of intercellular interactions (cooperative / antagonistic) on HGT transmission. The training programme is based on new research approaches that require the young researcher to have basic knowledge in microbiology, molecular biology and bioinformatics. The results of the research programme should provide answers to questions of intraspecific and interspecific horizontal gene transfer and further deepen the knowledge of the dynamics of gene transfer, for which there are several non-excludable hypotheses (influence of social interactions, sexual isolation).

#### DESIRED PROPERTIES / KNOWLEDGE

1. Completed second level university course or, as required by national legislation, and in the field of microbiology, biology, biochemistry, biotechnology or other natural sciences with best possible prior knowledge in bioinformatics, or willingness to undertake additional training in the field of microbiology for bioinformatics students.
2. Knowledge of bioinformatics (Python, programming language R or similar) is desirable.
3. Willingness for additional training in Slovenia and possibly abroad, presentation of research at domestic and international conferences.
4. Excellent knowledge of Slovenian and English language (written and conversational).
5. Driving license category B.
6. Ability to work and learn independently, but at the same time to work in a larger group.
7. Experience in research work and also in writing original scientific papers in Slovenian and English is an advantage.