Summer course in embryology of marine invertebrates-2
The White Sea Station, 2016

TENTATIVE PROGRAMME

Daily schedule: from 9:00 up to 20:00 - sampling and lab work, from 21:00 to 22:00 evening lectures. The labs are always open and people can work there as long as they want. Normally we have breakfast from 8:00 to 9:00, lunch from 13:00 to 14:00, and dinner 20:00–21:00. Time of 15-30 minutes coffee breaks is flexible, usually between lunch and dinner (except arrival and departure days). The correct time of field trips will be determined by the tidal schedule.

As needed on-duty students (by pairs) are responsible for the plankton sampling at the pier of the station or with row boats.

DAY 1 - SUNDAY - 12.06.2016
Arrival and accommodation at the White Sea Biological Station (WSBS); organization of the workplaces in the laboratory.

Lunch (14.00 – 15.00)
Excursion around the WSBS (15.00-17.00): Alexander Tzetlin and Yulia Khramova
Laboratory introduction (17.00-17.30): Nadezhda Rimskaya-Korsakova - «The basic principles of working with cultures of embryos and larvae in a laboratory; review accessible equipment and literature; general principles of zoological drawing»
Field excursion (17.30-18.30): Yulia Kraus and Igor Kosevich - plankton sampling with row boats and sorting of plankton samples in the laboratory; it is planned to obtain the gamets of hydromedusae next day; focus species - Aglantha digitale, Bougainvillia superciliaris Sarsia tubulosa.
Welcome lecture (19.00-20.00): Alexander Tzetlin - «History of the WSBS: past, present and future»
Dinner (20.00-21.00)
Welcome party (21.00-23.00): introduction of course participants (student and instructors), we encourage our students to give short talks or poster presentations devoted to their scientific interest.

DAY 2 - MONDAY - 13.06.2016
Breakfast (8.00-9.00)
Lecture (9.00-10.00): Nadezhda Rimskaya-Korsakova - «Introduction to embryology of marine invertebrates: the types of eggs, the types of cleavage, blastula, gastrulation, the formation of the mesoderm; organogenesis; metamorphoses»
Practical session (10.00-13.00): Yulia Kraus and Igor Kosevich - sorting of fresh plankton samples, observation of the various hydrozoan and young scyphozoan jellyfishes and comb jellies. Collecting fertilized eggs and embryos of Aglantha digitale, Bougainvillia superciliaris and Sarsia tubulosa that were placed into the lab the day before; observation and drawing of early development of hydrozoan cnidarians.
Training skill: Yulia Kraus and Igor Kosevich - identifying proliferating cells by EdU labeling. Labelling and fixation of A. digitale embryos and larvae.
Lunch (13.00 – 14.00)
Lecture (14.00 – 15.00) : Leica specialists - “Leica Microsystems: equipment and technologies for embryology”
Practical session (15:00-18:30, parallel activities): Leica specialists work individually with each pair of students - introduction to light microscopy for visualization and documentation of embryos of different types (using cnidarian embryos and larvae).
Yulia Kraus and Igor Kosevich – the rest of the group works on observation and drawing of hydrozoan planula – larvae (A. digitale, B. superciliaris) and direct transformation of planulae into medusae (metamorphosis of A. digitale).
Field excursion (18.30-20.00): collection of the various hydropolyps (especially, Gonothyrea loveni), various ephyrae, scyphistomae and anthozoan Aulactinia stella at the Eremei Rapids. Besides, collection of the egg clutches of polychaetes (Annelida) and nudibranchs (Mollusca). Sorting of samples in the laboratory.
Dinner (20.00-21.00)
DAY 3 - TUESDAY - 14.06.2016
Breakfast (8.00-9.00)
Lecture (9:00-10.00): Yulia Kraus - «Diversity and plasticity of cnidian developmental pathways»
Practical session (10.30-13:00): observation and drawing of metamorphosis of the A. digitale; young scyphozoan medusae and developing actinia polyps isolated from the maternal gastric cavity.
Training skill (10:30-13:00): Yulia Kraus and Igor Kosevich - identifying proliferating cells by EdU labeling (start of the protocol before morning lecture). Washing, click-reaction, glycerol embedding etc.
Lunch (13.00 – 14.00)
Lecture (14.00 – 15.00) : Olympus specialists - "Olympus: equipment and technologies for embryology"
Practical session (15:00-18:30, parallel activities): Olympus specialists work individually with each pair of students - introduction to light microscopy for visualization and documentation of embryos of different types (using cnidian embryos and larvae).
Lev Beloussov and Denis Nikishin - development and metamorphosis of Gonothyrea loveni, a hydropolypp with the reduced medusa form.
Field excursion (18.30-20.00): collection of various annelids and clutches of Phyllodoce maculata inhabiting intertidal zone in close vicinity to the station; sorting animals and clutches in the laboratory
Dinner (20.00-21.00)
Lecture (21.00-22.00): Lev Beloussov - "Thecate hydroids (Leptomedusae) as morphogenetic machines».

DAY 4 - Wednesday- 15.06.2016
Breakfast (8.00-9.00)
Lecture (9:00-10.00): Andreas Hejnl - «Introduction to Spiralia»
Lunch (13.00 – 14.00)
Lecture (14.00 – 15.00): Natalia Budaeva - «Reproduction and Development of Annelida»
Practical session (15.00-18.00, parallel activities): Natalia Budaeva and Andreas Hejnl - observation and drawing of diversity of trochophore larvae from the plankton
Yulia Kraus and Igor Kosevich – cLSM sessions for visualization of the proliferating embryonic and larval cells.
Practical session (18.00-20.00): continuation of metamorphosis experiments of Gonothyrea loveni, working with hydroid and annelid cultures.
Dinner (20.00-21.00)
Lecture (21.00-22.00): Yulia Kraus - «What do not we know about the embryonic organizers?»

DAY 5 - Thursday - 16.06.2016
Breakfast (8.00-9.00)
Practical session (9.00-11.00, parallel activities): Natalia Budaeva and Nadezhda Rimskaya-Korsakova - development of annelid Phyllobole maculata laying egg clutches and viviparous Circeis armoricana.
Andreas Hejnl - immunocytochemistry and confocal microscopy - Fixation and Blocking of specimens.
Lunch (13.00 – 14.00)
Lecture (14.00-15.30): Andreas Hejnl and Andreas Wanninger - introduction to immunocytochemistry and confocal microscopy
Practical session (15.30-18.30 parallel activities):
1) students projects on immunocytochemistry and confocal microscopy using various larvae from the plankton samples (students will work in pairs; 1 instructor per student pair: Andreas Hejnl, Andreas Wanninger, Denis Nikishin, Stanislav Kremnyov, Nadezhda Rimskaya-Korsakova). Continuation of projects: primary antibodies application
2) Natalia Budaeva and Nadezhda Rimskaya-Korsakova - continuation working with earlier set annelid cultures.
Dinner (20.00-21.00)
Lecture (21.00-22.00): Vladimir Malakhov - «Ciliary bands and filtration mechanisms in larvae and adults of invertebrates»

DAY 6 - Friday - 17.06.2016
Breakfast (8.00-9.00)
Lecture (9.00-10.00): Andreas Wanninger - «Development of Gastropoda (Mollusca)»
Practical session (10.00-13.00): Andreas Wanninger and Yulia Khramova - gastropod development: Littorina saxatilis and limpet Testudinalia tessellata. Dissection of the viviparous gastropod Littorina saxatilis, observation of the different cleavage stages. Culture set-up of the collected cleavage stages. Stimulation of spawning of limpets Testudinalia tessellata, fertilization, cultures set-up.
Lunch (13.00 – 14.00)
Practical session (14.00-20.00, parallel activities):
1) continuation of projects on immunocytochemistry: secondary antibodies application.
2) sorting plankton sampling and drawing the molluscan embryos and larvae (chitons, gastropods, bivalves). Observation and drawing of various molluscan egg clutches collected earlier at the Eremei rapids (like *Epheria vinca*, *Buccinum undatum*, *Margarites helicinus*, *Littorina obtusata*, *Cryptonatica affinis*, *Dendronotus frondosus* and various nudibranchs).
3) continuation working with earlier set-up cultures.
Dinner (20.00-21.00)
Lecture (21.00-22.00): **Andrey Ostrovsky** - «invertebrate life histories. Part 1»

**DAY 7 - Saturday - 18.06.2016**
Breakfast (8.00-9.00)
Lecture (9.00-10.00): **Andreas Wanninger** - «Development of Bivalvia (Mollusca)»
Practical session (10.00-13.00): **Andreas Hejnol and Andreas Wanninger** - development of bivalve *Mytilus edulis*, stimulation of spawning, artificial fertilization of gametes, observation and drawing of cleavage stages, onchostoma and veliger. Cultures set-up.
Practical session (12.00-13.00, parallel activity): continuation of projects on immunocytochemistry: embedding specimens.
Lunch (13.00 – 14.00)
Practical session (14.00-18.00): continuation working with cultures of *M. edulis* and other previously set cultures.
Practical session (15.00-18.00, parallel activity): continuation of projects on immunocytochemistry: CLSM session (individually with each pair of students).
Field excursion (18.00-20.00): collection of bryozoan colonies inhabiting intertidal zone in close vicinity of the WSBS; sorting animals and clutches in the laboratory
Dinner (20.00-21.00)
Lecture (21.00-22.30): **Andrey Ostrovsky** - «Invertebrate life histories. Part 2»

**DAY 8 - Sunday - 19.06.2016**
Breakfast (9.00-10.00)
Lecture (10.00-11.00): **Andrey Ostrovsky** - «Reproduction and life cycles of Bryozoa. Part 1»
Practical session (11.00-14.00): **Olga Kotenko** - «Embryonic and postembryonic development of marine bryozoans Gymnolaemata», focus species: *Flustrellidra hispida*, *Cribrillina annulata*, *Celleporella hyspida*, and larvae of *Electra pilosa* from plankton samples.
Lunch (14.00 – 15.00)
Practical session (15.00-18.00): working with earlier set-up cultures.
Practical session (15.00-18.00, parallel activity): continuation of projects on immunocytochemistry: CLSM session (individually with each pair of students).
Round table (18.00-20.00): all instructors - tools of visualization of nervous system, including immunocytochemistry and cLSM
Dinner (20.00-21.00)

**DAY 9 - MONDAY - 20.06.2016**
Breakfast (8.00-9.00)
Lecture (9.00-10.30): **Andrey Ostrovsky** - «Reproduction and life histories of Bryozoa. Part 2»
Practical session (10.30-13.00): **Olga Kotenko and Igor Kosevich** - «Development of bryozoans Cyclostomata (Stenolaemata; Bryozoa). Polyembryony».
Lunch (13.00 – 14.00)
Practical session (14.00-20.00): working with earlier set-up cultures.
Practical session (14.00-20.00): continuation of projects on immunocytochemistry: CLSM session (individually with each pair of students). Discussion of results of immunocytochemical projects.
Dinner (20.00-21.00)
Lecture (21.00-22.30): **Grigory Genikhovich** - «How an embryo makes its choices?»

**DAY 10 - TUESDAY - 21.06.2016**
Breakfast (8.00-9.00)
Practical session (9.00-13.00): cLSM microscopy of the specimens stained with antibodies (students working by pairs)/ discussion of results of immunocytochemical projects/ rest of the students working with earlier set-up cultures
Lunch (13.00 – 14.00)
Lecture (14.00-15.00) **Grigory Genikhovich** - «Mechanism of embryonic development»
Practical session (15.00-18.30): **Grigory Genikhovich and Yulia Kraus** - Set-up of experiments on the pharmacological modulation of Wnt- FGF- and Nodal- signaling pathways in the representatives of cnidarians, annelids and molluscs + seastar (students work by pairs; one instructor per pair: Grigory Genikhovich, Yulia Kraus, Andreas Hejnol, Denis Nikishin and Stanislav Kremnyov and others).

Round Table (18.30-20.00): all instructors - nervous system formation in embryos and larvae of invertebrates

Dinner (20.00-21.00)

Lecture (21.00-22.00): **Grigory Genikhovich** - «How to establish, maintain and pattern body axes. Part 1»

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**DAY 11 - Wednesday - 22.06.2016**

Field excursion (7.00-8.00): collection trip to Black Rocks for amphipods and isopods living at the intertidal zone

Breakfast (8.00-9.00)

Lecture (9.00-10.00): **Igor Kosevich** - «Development of Crustacea»

Practical session (10.30-13.00): **Igor Kosevich** - development of Crustacea, focus species: amphipods *Marinogammarus obtusatus, Caprella septentrionalis*, and various pelagic larvae.

Skill training (12.00-13.00): **Denis Nikishin** - time-lapse recording of development using embryos of amphipods and isopods.

Lunch (13.00 – 14.00)

Practical session (14.00-18.00): continuation experiments on signaling pathways (*G.loveni, O.limacina, L.saxatilis*)

Practical session (18.00-20.00): continuation working with crustacean cultures

Dinner (20.00-21.00)

Lecture (21.00-22.00): **Grigory Genikhovich** - «How to establish, maintain and pattern body axes. Part 2»

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**DAY 12 - Thursday - 23.06.2016**

Field excursion (7.00-8.00): collection trip for nematodes living at the intertidal zone

Breakfast (8.00-9.00)

Lecture (9.00-10.30): **Vladimir Malakhov** «Early development of free living marine nematodes»

Practical session (10.30-11.30): **Vladimir Malakhov** - set-up embryo cultures of nematode *Pontonema vulgare*

Practical session (11.30-13.00): **Igor Kosevich** - development of Crustacea, focus species: isopod *Jaera albifrons*.

Lunch (13.00 – 14.00)

Practical session (14.00-17.30): continuation experiments on signaling pathways (*G.loveni, O.limacina, L.saxatilis*)

Practical session (17.30-18.30): continuation working with crustacean cultures

Skill training (18.30-20.00): micromanipulation training in removing of fertilization envelope in sea urchin *Strongylocentrotus pallidus*

Dinner (20.00-21.00)

Lecture (21.00-22.00): **Igor Kosevich**: “Peculiarities of Module Organization in Hydrozoa”?

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**DAY 13 - Friday - 24.06.2016**

Breakfast (8.00-9.00)

Lecture (9.00-10.00): **Denis Nikishin** - «Introduction to Deuterostomia. Development of Echinodermata. Radial cleavage»

Practical session (10.30-13.00): **Carmen Andrikou and Denis Nikishin** - development of *Strongylocentrotus pallidus* (sea urchins collected in advance by divers). Spawning stimulation, observation of fertilization and early development stages. Set-up cultures of sea star embryos.

Lunch (13.00 – 14.00)

Practical session (14.00-16.00): completion of experiments on signaling pathways (*G.loveni, O.limacina, L.saxatilis*)

Practical session (16.00-19.00): observation and drawing of echinoderm larvae from plankton samples (bippinaria; echinopluteus and ophiopluteus)

Field excursion (19.00-20.00): collection sea stars *Asterias rubens* from the intertidal zone

Dinner (20.00-21.00)

Lecture (21.00-22.00): **Carmen Andrikou** - «Embryonic muscle development in echinoderms»

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**DAY 14 - Saturday - 25.06.2016**

Breakfast (8.00-9.00)


Lunch (13.00 – 14.00)

Practical session (14.00-16.00): **Grigory Genikhovich** - set up experiments on pharmacological modulation of the Wnt-, Nodal- and BMP-signaling pathways in sea star *Asterias rubens*.

Practical session (16.00-18.30): continuation observation of developing embryos of *Asterias rubens*. 
Round table (18.30-20.00): all instructors - diversity of signaling pathways in different invertebrate lineages
Dinner (20.00-21.00)
Lecture (21.00-22.00): Andrey Ostrovsky - «Matrotrophy in invertebrates»

DAY 15 - SUNDAY - 26.06.2016
Breakfast (9.00-10.00)
Day off. Excursion to Kos'yan Island. BBQ.
Practical session (18.00-20.00): continuation observation of developing embryos, continuation of experiments on signaling pathways (A. rubens)
Dinner (20.00-21.00)
Lecture (21.00-22.30): Alexander Tzeltlin - «Traditional fishery along the White Sea coast and recent state of the local recourses exploitation»

DAY 16 - MONDAY - 27.06.2016
Breakfast (8.00-9.00)
Lecture (9.00-10.30): Maria Semenova - «Development of Nemertea»
Practical session (10.30-12.00): Maria Semenova and Denis Nikishin - Development of nemertean Poseidon ruber.
Practical session (12.00-13.00): observation of earlier set-up embryo cultures
Lunch (13.00 – 14.00)
Practical session (14.00-16.00): continuation of experiments on signaling pathways (A. rubens)
Field excursion (16.00-18.00): sponge field collection to the intertidal zone
Round table (18.00-20.00): all instructors - diversity of invertebrate larvae metamorphosis in different invertebrate lineages
Dinner (20.00-21.00)
Lecture (21.00-22.00): ...

DAY 17 - TUESDAY - 28.06.2016
Breakfast (8.00-9.00)
Lecture (9.00-10.30): Alexander Ereskovsky - «General characteristic of sponges with emphasis on their reproduction and development»
Lecture (11.00-12.00): Alexander Ereskovsky and Andrey Lavrov - «Methods for sponge collection, fixation, and experimental work with sponges»
Practical session (12.00 - 13.00): Alexander Ereskovsky and Andrey Lavrov - set-up of experiments on reparative regeneration of Sycon sp. (collected by divers)
Lunch (13.00 – 14.00)
Field excursion (14.00-15.00): sponge collection at the intertidal zone
Practical session (15.00 - 18.00): Alexander Ereskovsky and Andrey Lavrov - set-up of experiments on reparative regeneration of Leucosolenia complicata and Halisarca dujardini. Set-up of experiments on cell dissociation and primmorphs formation of Halisarca dujardini and Haliclona aquaeductus
Practical session (18.00-20.00): completion of experiments on signaling pathways (A. rubens).
Dinner (20.00-21.00)
Lecture (21.00-22.00): Andreas Hejnol - «Current state of our knowledge of development of invertebrates»

DAY 18 - WEDNESDAY- 29.06.2016
Breakfast (8.00-9.00)
Lecture (9.00-10.30): Alexander Ereskovsky - «Comparative embryology of Porifera»
Practical session (10.30-12.00): Alexander Ereskovsky and Andrey Lavrov - sponge anatomy and reproductive elements description, fixation, drawing.
Lunch (13.00 – 14.00)
Practical session (14.00-20.00): Alexander Ereskovsky and Andrey Lavrov - 1) results of experiments of primmorphs formation of H. dujardini and H. aquaeductus, 2) observation and drawing of larvae of H. dujardini and Haliclona aquaeductus, description of their behavior and metamorphosis, 3) continuation of experiments on reparative regeneration of Sycon sp., Leucosolenia complicata, Halisarca dujardini (control, description, drawing, fixation).
Dinner (20.00-21.00)
Lecture (21.00-22.30): Andrey Prudkovsky – “The biodiversity and seasonality of planktonic larvae of invertebrates of the White Sea”
DAY 19 - Thursday - 30.06.2016
Breakfast (8.00-9.00)
Lecture (9.00-10.30): Maria Semenova - «Development of Tunicates»
Practical session (10.30-13.00): Maria Semenova - development of ascidians Halocynthia pyriformis and Molgula retortiformis, dissection of animals and observation and drawing of different developmental stages.
Lunch (13.00 – 14.00)
Practical session (14.00-16.00): observation of earlier set-up embryo cultures, observation of results of reparative experiments of sponges
Field excursion (16.00-17.30): for collection of hydroids at the Eremei rapids
Practical session (17.30-20.00): Lev Belousov, Igor Kosevitch, Yulia Kraus and Mark Martindale - diversity of realization of life cycles of hydrozoans Clava multicornis, Dynamena pumilla, Laomedea flexuosa, Coryna sarsi, inhabiting the Eremei rapids
Dinner (20.00-21.00)
Lecture (21.00-22.30): Lev Belousov - «Morphomechanical approach to embryonic development»

DAY 20 - Friday - 01.07.2016
Breakfast (8.00-9.00)
Practical session (9.00-13.00): last observations of all embryo cultures, finishing of preparation of drawings for a credit
Lunch (13.00 – 14.00)
Discussions (14.00-20.00): students and instructors discuss the results of the experimental projects (immunocytochemistry and signaling pathways) based on which students prepare oral presentations
Dinner (20.00-21.00)
Lecture (21.00-22.00): Alexander Ereskovsky - Asexual reproduction in animals

DAY 21 - Saturday - 02.07.2016
Breakfast (8.00-9.00)
Student presentations (9.00-13.00): oral presentation of the results of students’ projects (pharmacological experiment and immunocytochemistry).
Lunch (13.00 – 14.00)
Excursion to the Olenevsky Island (14:00-21:00): examination of students' drawings and discussion problems of invertebrate development. Gala dinner at the island with picturesque view of the unique for Karelia sandy beach.

DAY 22 - Sunday - 03.07.2016
Breakfast (9.00-10.00)
Departure