

Ecole Doctorale COMPLEXITE DU VIVANT – Fiche Projet CONCOURS

Fiche à nommer selon le format *Nom_Prenom* (sans accents ni cédilles), à enregistrer en format PDF et à renvoyer à l'adresse : edcdv@sorbonne-universite.fr

Nom et prénom du directeur de thèse (et si besoin du co-directeur) : BERTRAND Stéphanie ESCRIVA Hector

Le directeur de thèse et le co-directeur doivent impérativement avoir l'HDR ou équivalent

Coordonnées Tel : 0430192405/0468887390 e-mail : stephanie.bertrand@obs-banyuls.fr/hescriva@obs-banyuls.fr

Nom et prénom du co-encadrant (*non HDR*) (s'il y a lieu) :

Coordonnées Tel :

e-mail :

Y-a-t-il un candidat déjà identifié pour le projet: ☒ OUI ☐ NON

Nom et prénom du responsable de l'équipe : BERTRAND Stéphanie et ESCRIVA Hector

Intitulé de l'équipe : Evolution et Développement des Chordés

Nombre de chercheurs et enseignants-chercheurs statutaires de l'équipe titulaires d'une HDR (ou équivalent) : 2

Nom et prénom du responsable d'UMR ou de département: ESCRIVA Hector

Intitulé et N° d'UMR ou de département: Biologie Intégrative des Organismes Marins, BIOM, UMR7232

Signature du directeur d'UMR ou de département (vaut avis favorable pour le dépôt du projet) :

Titre du projet de thèse : *Evolution of motoneurons in chordates*

Spécialité : Evolution, Biologie du développement

Résumé du projet de thèse (1 page maximum, en anglais)

Pour les thèses avec 2 co-directeurs, ou en partenariat entre 2 laboratoires ou structures, indiquer la participation de chaque co-directeur et structure dans la gestion du projet.

Unlike the other chordates (i.e. urochordates and cephalochordates), vertebrates possess an extremely specialized structure in the anterior part of their body called the «head». In vertebrates, contrary to the trunk, where the paraxial mesoderm is segmented in somites, the head mesoderm appears as a non-segmented structure which gives rise to some of the head muscles. Interestingly, it is extensively accepted that the last common ancestor of all chordates possessed its body completely segmented from the most anterior to the most posterior part as extant cephalochordates (i.e. amphioxus). This raises the question of the appearance of the unsegmented head mesoderm. By studying somitogenesis in amphioxus, we proposed an evolutionary scenario in which the head mesoderm of vertebrates would derive from a lateral/ventral mesodermal component and not from a paraxial anterior mesoderm territory. From this hypothesis, the head mesoderm of vertebrates would be homologous to the ventral part of amphioxus anterior somites.

Head striated muscles in vertebrates are innervated by motoneurons of different nature: (1) the muscles deriving from the somites are associated to somatic spinal cord motoneurons, (2) the muscles that form from the pharyngeal mesoderm are innervated by branchial motoneurons from the hindbrain, and (3) the extraocular muscles, which develop from the prechordal mesoderm, are associated to specific motoneurons localized at the midbrain-hindbrain junction. In amphioxus, the somatic motoneurons for the locomotory muscles that derive from the somites are hypothesized to be homologues of vertebrate spinal motoneurons although they show a different mode of neuromuscular junction, at the surface of the neural tube. The motoneurons innervating the mouth and pharyngeal muscles were on another hand proposed as homologues of branchial motoneurons. However, the data on motoneurons and their ontology in amphioxus are still scarce and lack more detailed genetic and molecular

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description. The objective of the project is to decipher in detail the motoneuron atlas in amphioxus larva and adult as well as to define their developmental origin in order to test for their homology with vertebrates motoneuron classes. This will allow us to test for our hypothesis concerning the evolution of the vertebrate head muscles. The main tasks of the project are as follows:

- 1) Characterizing motoneurons in amphioxus larva and adult at the molecular level. The PhD student will analyze during development and in adult amphioxus the expression pattern of genes known as markers of specific motoneuron populations in vertebrates by in situ hybridization, and/or by immunostaining (Collaboration J-F. Brunet, IBENS, Paris).
- 2) Characterizing the developmental trajectory of motoneurons and the neural atlas in adult amphioxus. The team is producing scRNA-seq data at different developmental stages of amphioxus embryonic development from early stages to the larval stage (collaboration with the teams of A. Sebe-Pedros and M. Irimia at the CRG, Barcelona). The PhD student will participate to the analysis of these data in order to define the transcriptional trajectories of amphioxus motoneurons. The student will also generate scRNA-seq data of the amphioxus adult central nervous system (collaboration with the teams of A. Sebe-Pedros (CRG, Barcelona) and J-F Brunet (IBENS, Paris)).
- 3) Characterization of muscles innervation in amphioxus. As previously stated, body musculature presents peculiar neuromuscular junctions with muscle cells contacting directly with neurons of the neural tube. The objective of the student will be to better characterize such junctions at the molecular level. The second aim will be to study the innervation of the mouth and pharynx muscles by using fine imaging techniques and 3D reconstructions.

The student will be supervised by both Stéphanie Bertrand and Hector Escriva that work in the same research team and that have complementary research skills.

Faisabilité du projet de thèse (1/2 page maximum, en anglais)

Expliciter la faisabilité du projet en terme d'expertise de l'équipe d'accueil, des collaborations potentielles qui pourront être mises en place pour certains aspects du projet, de la disponibilité des appareils nécessaires au bon déroulement du projet...

Our team is leader in the use of amphioxus as a model system to study chordate evolution (Bertrand and Escriva 2011, Escriva 2018) and is providing access to the animal to a large community of researchers through the EMBRC infrastructure or the ASSEMBL+ European project. We led the European Amphioxus Genome project and recently published, together with other laboratories and with the Genoscope, the genome and epigenome of the amphioxus species we are working with (*Branchiostoma lanceolatum*) (Marletaz, Firbas et al. 2018). We therefore have access to all the biological and technical material in order to work with this animal. We have been working on deciphering the evolutionary history of vertebrate head mesoderm (Aldea et al., 2019) and the thesis proposal is the continuation of a long-term team project. The single-cell RNA-seq experiments will be achieved thanks to a collaboration with two laboratories in Barcelona (Manuel Irimia and Arnau Sebe-Pedros teams at the CRG) and the project is also part of a collaboration with the team of Jean-François Brunet (IBENS, Paris).

Thèses actuellement en cours dans l'équipe

Tous les encadrements doivent être indiqués (y compris les co-directions avec un autre HDR pour des doctorants d'une autre ED, et les encadrements dans le cadre de programmes doctoraux tels qu'IPV, FDV...)

Nom et Prénom du doctorant	Directeur(s) de thèse	Année de 1ère inscription	ED	Financement
SOUBIGOU Anaël	Stéphanie BERTRAND et Hector ESCRIVA	2020	ED515	Bourse Ministère

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Trois publications récentes du directeur de thèse (du co-directeur ou du co-encadrant s'il y a lieu). Mettre en gras le nom du directeur de thèse.

- 1: Aldea D, Subirana L, Keime C, Meister L, Maeso I, Marcellini S, Gomez-Skarmeta JL, **Bertrand S***, **Escriva H***. Genetic regulation of amphioxus somitogenesis informs the evolution of the vertebrate head mesoderm. Nat Ecol Evol. 2019 Aug;3(8):1233-1240. (* corresponding authors)
- 2: Marlétaz F, Firbas PN, Maeso I, Tena JJ, Bogdanovic O, Perry M, Wyatt CDR, de la Calle-Mustienes E, **Bertrand S**, Burguera D, Acemel RD, van Heeringen SJ, Naranjo S, Herrera-Ubeda C, Skvortsova K, Jimenez-Gancedo S, Aldea D, Marquez Y, Buono L, Kozmikova I, Permanyer J, Louis A, Albuixech-Crespo B, Le Petillon Y, Leon A, Subirana L, Balwierz PJ, Duckett PE, Farahani E, Aury JM, Mangenot S, Wincker P, Albalat R, Benito-Gutiérrez È, Cañestro C, Castro F, D'Aniello S, Ferrier DEK, Huang S, Laudet V, Marais GAB, Pontarotti P, Schubert M, Seitz H, Somorjai I, Takahashi T, Mirabeau O, Xu A, Yu JK, Carninci P, Martinez-Morales JR, Crollius HR, Kozmik Z, Weirauch MT, Garcia-Fernández J, Lister R, Lenhard B, Holland PWH, **Escriva H***, Gómez-Skarmeta JL*, Irimia M*. Amphioxus functional genomics and the origins of vertebrate gene regulation. Nature. 2018 Dec;564(7734):64-70. (* corresponding authors)
- 3: Le Petillon Y, Luxardi G, Scerbo P, Cibois M, Leon A, Subirana L, Irimia M, Kodjabachian L, **Escriva H***, **Bertrand S***. Nodal/Activin Pathway is a Conserved Neural Induction Signal in Chordates. Nat Ecol Evol. 2017 Aug;1(8):1192-1200. (* corresponding authors)

Docteurs encadrés par le directeur de thèse ayant soutenu entre la date de dépôt de ce dossier et il y a 5 ans et publications relatives à leur sujet de thèse. Mettre en gras le nom du directeur de thèse et celui du docteur.

Nom Prénom : MEISTER BLANCO Lydvina	Date de soutenance : 03/10/2021 Durée de thèse (en mois) : 48 Ecole Doctorale : ED515
Publications :	
1: Aldea D, Subirana L, Keime C, Meister L , Maeso I, Marcellini S, Gomez-Skarmeta JL, Bertrand S , Escriva H . Genetic regulation of amphioxus somitogenesis informs the evolution of the vertebrate head mesoderm. Nat Ecol Evol. 2019 Aug;3(8):1233-1240.	
2: Meister L , Escriva H* , Bertrand S* . FGF signalling pathway function in cephalochordates enlightens the evolution of the prechordal plate. Under revision at Development.	
Nom Prénom : LEON FLORIAN Luis Anthony	Date de soutenance : 13/11/2018 Durée de thèse (en mois): 48 Ecole Doctorale : ED515
Publications :	
1. Aldea D, Leon A , Bertrand S , Escriva H . Expression of Fox genes in the cephalochordate Branchiostoma lanceolatum. Frontiers in Ecology and Evolution. 2015 28 July.	
2. Le Petillon Y, Luxardi G, Scerbo P, Cibois M, Leon A , Subirana L, Irimia M, Kodjabachian L, Escriva H , Bertrand S . Nodal/Activin Pathway is a Conserved Neural Induction Signal in Chordates. Nat Ecol Evol. 2017 Aug;1(8):1192-1200.	

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3. Marlétaz F, Firbas PN, Maeso I, Tena JJ, Bogdanovic O, Perry M, Wyatt CDR, de la Calle-Mustienes E, **Bertrand S**, Burguera D, Acemel RD, van Heeringen SJ, Naranjo S, Herrera-Ubeda C, Skvortsova K, Jimenez-Gancedo S, Aldea D, Marquez Y, Buono L, Kozmikova I, Permanyer J, Louis A, Albuixech-Crespo B, Le Petillon Y, **Leon A**, Subirana L, Balwierz PJ, Duckett PE, Farahani E, Aury JM, Mangelot S, Wincker P, Albalat R, Benito-Gutiérrez E, Cañestro C, Castro F, D'Aniello S, Ferrier DEK, Huang S, Laudet V, Marais GAB, Pontarotti P, Schubert M, Seitz H, Somorjai I, Takahashi T, Mirabeau O, Xu A, Yu JK, Carninci P, Martinez-Morales JR, Crollius HR, Kozmik Z, Weirauch MT, Garcia-Fernández J, Lister R, Lenhard B, Holland PWH, **Escriva H**, Gómez-Skarmeta JL, Irimia M. Amphioxus functional genomics and the origins of vertebrate gene regulation. *Nature*. 2018 Nov 21.

4. **Leon A**, Subirana S, Magre K, Cases I, Tena JJ, Irimia M, Gomez-Skarmeta JL, **Escriva H***, **Bertrand S***. Gene regulatory networks of epidermal and neural fate choice in a chordate. Under revision at *Mol. Biol. Evol.*

Nom Prénom : ALDEA ARIAS Daniel

Date de soutenance : 20/09/2016

Durée de thèse (en mois):48

Ecole Doctorale :ED515

Publications :

1: **Aldea D**, Subirana L, Keime C, Meister L, Maeso I, Marcellini S, Gomez-Skarmeta JL, **Bertrand S**, **Escriva H**. Genetic regulation of amphioxus somitogenesis informs the evolution of the vertebrate head mesoderm. *Nat Ecol Evol*. 2019 Aug;3(8):1233-1240.

2 :Marlétaz F, Firbas PN, Maeso I, Tena JJ, Bogdanovic O, Perry M, Wyatt CDR, de la Calle-Mustienes E, **Bertrand S**, Burguera D, Acemel RD, van Heeringen SJ, Naranjo S, Herrera-Ubeda C, Skvortsova K, Jimenez-Gancedo S, **Aldea D**, Marquez Y, Buono L, Kozmikova I, Permanyer J, Louis A, Albuixech-Crespo B, Le Petillon Y, Leon A, Subirana L, Balwierz PJ, Duckett PE, Farahani E, Aury JM, Mangelot S, Wincker P, Albalat R, Benito-Gutiérrez E, Cañestro C, Castro F, D'Aniello S, Ferrier DEK, Huang S, Laudet V, Marais GAB, Pontarotti P, Schubert M, Seitz H, Somorjai I, Takahashi T, Mirabeau O, Xu A, Yu JK, Carninci P, Martinez-Morales JR, Crollius HR, Kozmik Z, Weirauch MT, Garcia-Fernández J, Lister R, Lenhard B, Holland PWH, **Escriva H**, Gómez-Skarmeta JL, Irimia M. Amphioxus functional genomics and the origins of vertebrate gene regulation. *Nature*. 2018 Dec;564(7734):64-70.

3: Acemel RD, Tena JJ, Irastorza-Azcarate I, Marlétaz F, Gómez-Marín C, de la Calle-Mustienes E, **Bertrand S**, Diaz SG, **Aldea D**, Aury JM, Mangelot S, Holland PW, Devos DP, Maeso I, **Escriva H**, Gómez-Skarmeta JL. A single three-dimensional chromatin compartment in amphioxus indicates a stepwise evolution of vertebrate Hox bimodal regulation. *Nat Genet*. 2016 Mar;48(3):336-41.

4: **Bertrand S**, **Aldea D**, Oulion S, Subirana L, de Lera AR, Somorjai I, **Escriva H**. Evolution of the Role of RA and FGF Signals in the Control of Somitogenesis in Chordates. *PLoS One*. 2015 Sep 15;10(9):e0136587.

5. **Aldea D**, Leon A, **Bertrand S**, **Escriva H**. Expression of Fox genes in the cephalochordate *Branchiostoma lanceolatum*. *Frontiers in Ecology and Evolution*. 2015 28 July.

6: **Aldea D**, Hanna P, Munoz D, Espinoza J, Torrejon M, Sachs L, Buisine N, Oulion S, **Escriva H**, Marcellini S. Evolution of the vertebrate bone matrix: an expression analysis of the network forming collagen paralogues in amphibian osteoblasts. *J Exp Zool B Mol Dev Evol*. 2013 Sep;320(6):375-84.