

***MASTER “SCIENCES, TECHNOLOGIES, SANTÉ”
MENTION “BIOLOGIE ET SANTÉ ”***

PORTEUR : Pr OLIVIER OUDAR, UNIVERSITE SORBONNE PARIS NORD

Parcours M2

“DIR : Development, Inflammation, Regeneration”

Coordinateur

Pr Catherine CHAUSSAIN, Université Paris Cité

Co-responsables

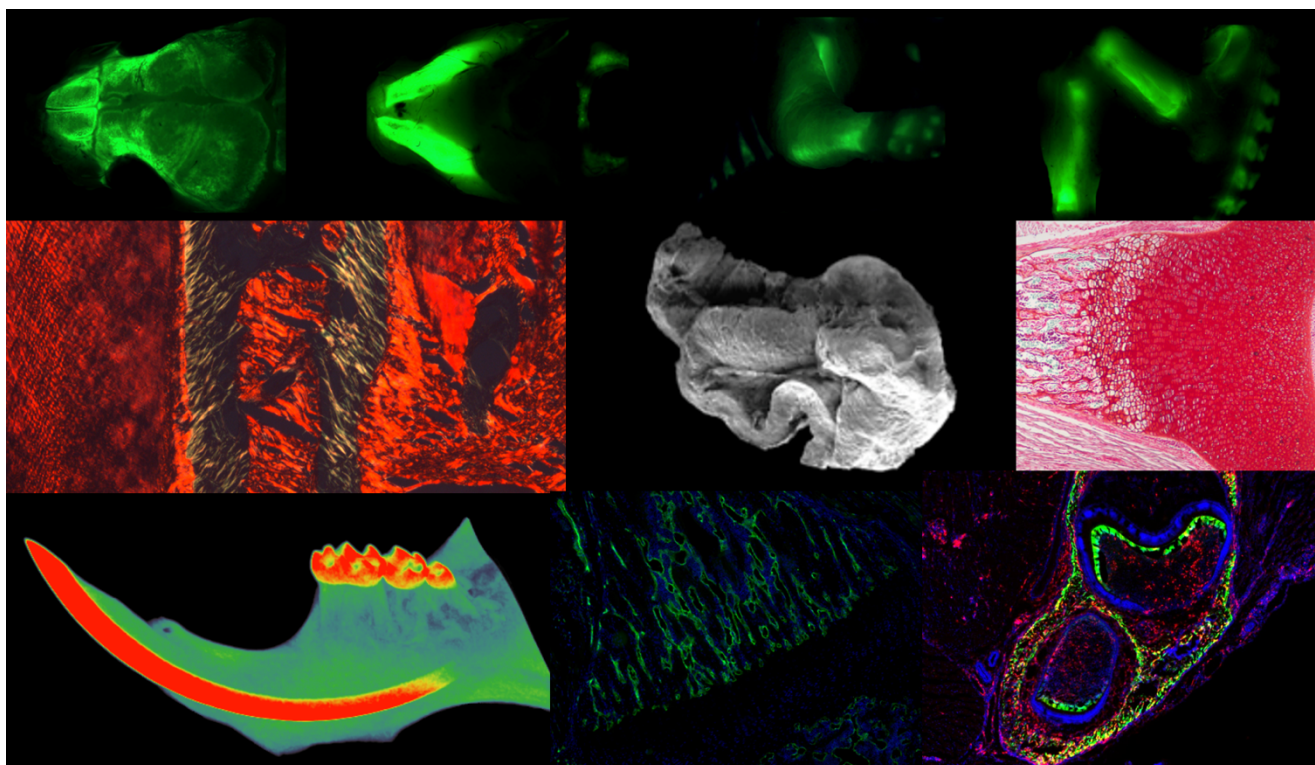
Pr Hang Korng EA, Université Paris Cité

Pr Ariane BERDAL, Université Paris Cité

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2022-2023



Le **parcours « DIR : Développement, Inflammation et Régénération »** a pour objectif de former des étudiants intéressés par les recherches d'interface entre sciences et santé. Il est ainsi ouvert aux étudiants de ces deux secteurs et d'autres formations (vétérinaire, ingénieur...). Le Master permet d'appréhender les différents aspects des pathologies du squelette et des minéralisations ectopiques. La formation propose un panel volontairement étendu de modélisations expérimentales - biologie cellulaire et moléculaire, physiopathologie, immunologie génétique du développement, caractérisation structurale et physicochimique, biomatériaux, chirurgie expérimentale, ou thérapie cellulaire. L'étudiant acquièrera une expertise dans l'analyse des mécanismes fondamentaux de morphogenèse, de défense immunitaire et de destruction des tissus en tant que tels et comme modèles dans l'exploration thérapeutique (médicament, cellule, biomatériau). **Cet enseignement en anglais** prépare des professionnels à l'innovation en santé, par l'initiation aux démarches de recherche translationnelle partant de questions physiopathologiques d'enjeu majeur en santé publique à leur résolution dans des applications cliniques ou industrielles et avec des patients-acteurs.

Mots clefs : cellules-souches, inflammation, ostéo-articulaire, oral, dentaire, minéralisation, remodelage bioingénierie, thérapie

The English masterclass "DIR: Development, Inflammation and Regeneration" aims at training research students from diverse backgrounds and areas of science, health, veterinary and engineering schools. The program introduces a panel of experimental strategies in cellular biology, physiology, pathology and biotherapy. The Master will introduce cellular (mesenchymal stem cells) and molecular determinants of the calcified tissues (bone, cartilage, tooth, ectopic calcifications), its analysis from nano-scale to anatomical level including biomechanics. Integrated cell biology will be presented in connection with the domains of developmental biology, pharmacology, immunology and genetics with a special focus on inflammation. The theme of tissue engineering and biomaterials will introduce other scientific interactions with physics, chemistry, in interface with industry.

Key words: stem cells, inflammation, musculoskeletal and oral tissues, tooth, mineralization, remodeling, regeneration, tissue engineering, therapies

Programme Parcours M2 DIR

SEMESTRE 3				
6 UE maximum au choix (18 ECTS)	UE 1	Stem cells : from fundamental research to therapeutic applications	B. Fournier, A. Poliard, D. Modrovski	3 ECTS
	UE 2	Bone cell biology and environment	M. Cohen-Solal, A. Coudert, V Bousson	3 ECTS
	UE 3	Cellular and molecular biology of inflammation	G. Falgarone, M. Gosset, L. Tourneur	3 ECTS
	UE 4	Cartilage metainflammation and inflammaging	E Hay, J. Bouchet, F. Rannou, M. Biosse Duplan	3 ECTS
	UE 5	Biomaterials and Tissue engineering	J. Isaac, M. Bensidhoum, C. Nguyen, C. Gorin	3 ECTS
	UE 6	Genetics and Pathophysiology	C. Bardet, C. Collet, C. Gaucher, S. Houari	3 ECTS
	UE 7	Physiologic and heterotopic mineralization: crystallization and cellular aspects	H.K. Ea, C. Chaussain, A. Berdal	3 ECTS
	UE libre 1 au choix	1 UE libre parmi les autres spécialités de la mention		3 ECTS
UE obligatoire	UE9+UE10	Soutenance projet de recherche (UE9) en anglais (UE10)	–	12 ECTS (6+6)
SEMESTRE 4				
UE obligatoire	UE 1	Stage pratique en laboratoire avec Soutenance orale	–	30 ECTS

M2 program “DIR : Development, Inflammation, Regeneration”

All the classes are in English

<u>Coordination</u>	<u>Co-responsables</u>
Pr Catherine CHAUSSAIN, Université Paris Cité	Pr Hang Korng EA, Université Paris Cité Pr Ariane BERDAL, Université Paris Cité Pr Géraldine FALGARONE, Université Sorbonne Paris Nord

UE	Intitulé de l'UE – Enseignants responsables	Contenu de l'UE	Compétences visées	Dates et lieux des enseignements
UE 1	Stem cells : from fundamental research to therapeutic applications (B. Fournier, A. Poliard, D. Modrovski)	This EU combines basic knowledge on stem cells, their differentiation pathways and their concrete applications in tissue engineering	Theoretical knowledge and therapeutic use of stem cells	3ECTS <i>Garancière</i>
UE 2	Bone cell biology and environment (M. Cohen-Solal, A. Coudert, V. Bousson)	Functions and regulations of bone cells are described at the molecular, cellular and tissue levels	Knowledge in cell biology and bone pathophysiology	3ECTS <i>Lariboisière</i>
UE3	Cellular and molecular biology of inflammation (G. Falgarone, M. Gosset, L. Tourneur)	The cellular and molecular actors of immunity and inflammation are presented in their pathophysiological context and their biotherapies	Mechanisms of inflammation including bases of osteoimmunology, immunological interactions and biotherapies	3ECTS <i>Bobigny</i>
UE4	Cartilage metainflammation and inflammaging (E Hay, J. Bouchet, F. Rannou, M. Biosse Duplan)	Chondrocyte differentiation, endochondral ossification and its modulations are presented in physiological and pathological contexts.	Biological knowledge and experimental models of cartilage	3ECTS <i>Lariboisière</i>
UE5	Biomaterials and Tissue engineering (J. Isaac, M. Bensidhoum, C. Gorin, Nguyen C)	The different components (cells, three-dimensional organization related to bioactive materials and factors) are presented through bone and dental tissue engineering.	Knowledge of chemistry/physics/biology interfaces and development of preclinical trials for innovative tissue engineering therapies	3ECTS <i>Garancière</i> <i>Villemin</i> <i>ENSAM</i>
UE6	Genetics and Pathophysiology (C. Bardet, C. Collet, C. Gaucher, S. Houari)	Genetics and epigenetics, mineral metabolism, tools and regulations in translational research	Translational approaches of genetics through pathophysiological studies of rare diseases	3ECTS <i>Montrouge</i>
UE 7	Physiologic and heterotopic mineralization : crystallization and cellular aspects (H.K. Ea, C. Chaussain, A. Berdal)	This course will address biologic and physico-chemical mechanisms involved in pathologic calcifications	Knowledge on the role of inflammation, extracellular matrix, mechanical stress in ectopic calcifications. Therapeutic approaches.	3ECTS <i>Lariboisière</i>

Program UE-1
Stem Cells : From fundamental to therapeutics

Contacts : A. Poliard, D. Modrowski, B. Fournier

Site : Faculté de chirurgie dentaire de Garancière, 5 rue Garancière, 75006 Paris

	Monday
11h00-12h30	Stem cells: General introduction (Benjamin Fournier , EA 2496, Paris Descartes, Montrouge)
13h15-15h45	Pluripotent stem cells and therapy (Gilles Lemaître , I-stem, Corbeil-Essones)
16h-18h30	Stem cells, cell therapy ethics (Christine Dosquet , Présidente du Comité d'Evaluation éthique/IRB Inserm, Paris)
	Tuesday
9h15-11h45	Stem cells and bone repair. (C. Colnot , INSERM U1163, Institut Imagine, Paris)
13h15-15h45	Hematopoietic stem cells (CSH) and their niche during human embryonic development: applications to pediatric pathologies (Michèle Souyri , INSERM UMR-S 1131, Paris)
16h00-18h30	Therapeutic potential of human mesenchymal stromal cells (Morad Bensidhoum , B20A, CNRS, Paris)
	Wednesday
9h15-11h45	Muscle stem cells, and clinical applications (Jean-Thomas Vilquin , Institut de myologie, Paris)
13h15-15h45	Stem cells and gingival repair (François Ferre , INSERM UMRS 1138, Cordeliers, Paris)
16h00-18h30	Stem cells and stroke (Nathalie Kubis , INSERM, UMR1148, LVTS, Paris)
	Thursday
09h15-11h45	Dental pulp stem cells and et tissue repair (Anne Poliard , EA 2496, Paris Descartes, Montrouge)
13h15-15h45	Stem cells and cancer (Dominique Modrowski , INSERM UMR 1132, Paris)
16h00-18h30	Cell therapy in dermatology (Marina Trouillas , INSERM U1197- Hôpital Percy, Clamart)
	Friday
9h00-11h	Interactions between academics and industry: Pulp therapy (Stéphane Simon , Inserm UMRS 1138, Cordeliers, Paris & Intervenant Dentsply)
13h-15h	Exam

Program UE-2
Bone cell biology and environment

Contacts : M. Cohen-Solal, A. Coudert, V. Bousson

Site: meeting room of Inserm U1132, department of Rheumatology, Hôpital Lariboisière, 2 rue Ambroise Paré, 75010 Paris – Tel : 01 49 95 63 58

	Monday : Actors and tools
10h00-12h00	Physiology of bone modeling and remodeling. (<i>D. Chappard, GEROM, Université d'Angers</i>)
13h00-14h30	Techniques in bone molecular and cellular biology (<i>E. Hay, Inserm U1132, UP Cité</i>)
14h45-16h15	Osteoclast : from cell to tissue function (<i>Anne Blangy, INSERM UMR, Université Montpellier</i>)
16h30-18h00	Osteoblasts & osteocytes : regulation of bone formation and more (<i>A. Coudert, INSERM UMR11132, Université Paris Cité</i>)
	Tuesday : Formation - Repair
9h00-10h30	Animal models in bone physiology and pathophysiology <i>P. Clément-Lacroix, C. Jagerschmidt, Galapagos SA, Romainville</i>
10h45-12h15	Bone vascularisation (<i>MH Lafage-Proust, Université de St-Etienne</i>)
14h00-15h30	Bone quality and et repair (<i>G. Odri, Inserm U1132, Paris</i>)
15h30-17h30	Round table: bone formation
	Wednesday : Integrated bone
9h00-10h30	Neurological control of bone remodeling (<i>F. Oury, Inserm, INSERM</i>)
10h45-12h15	Bone as an endocrine tissue (<i>Cyrille Confavreux, INSERM U1033 ; CHU Lyon</i>)
14h00-15h30	Bone marrow adiposity in bone (<i>C. Chauveau, Boulogne/mer, Université du littoral Côte d'Opale</i>)
15h30-17h30	Round table: interaction of bone with other tissues
	Thursday : Bone and its environment
9h00-10h30	Cellular mechanisms of primary bone tumors (<i>F. Verrechia, INSERM U957, Université de Nantes</i>)
10h45-12h15	Genetic and epigenetic mechanisms of bone tumors (<i>F. Lamoureux, Université de Nantes</i>)
14h00-15h30	Bone remodeling and immune system (<i>C. Blin, Université de Nice</i>)
15h30-17h30	Round table: bone inflammation
	Friday : Imaging
9h00-10h30	How imaging research can improve fracture risk (<i>V Bousson, Université Paris Cité</i>)
10h45-12h15	DEXA – body composition in real life (<i>S. Kolta, Université Paris Cité</i>)
14h00-15h30	Bone quality : methods to assess bone strength ex vitro and in vivo (<i>P. Rouch, Arts et Métiers Paris Tech</i>)
15h45-17h15	Bone biomarkers: methodology and clinical relevance (<i>Pawel. Szulc , INSERM U1033</i>)
	Saturday
9h00-12h00	Tests/Exams

PROGRAM UE-3 CELLULAR AND MOLECULAR BIOLOGY OF INFLAMMATION
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Contacts : Géraldine Falgarone, Marjolaine Gosset, Léa Rémy-Tourneur

Information: Géraldine Falgarone g.falgarone@aphp.fr

Site : UFR Léonard de Vinci, Université Paris 13

Bâtiment de l'Illustration 74 rue Marcel Cachin, 93, Bobigny

Monday	Cellular actors of immunity and inflammation
9h00	Welcome Innate immunity and Toll receptors (G Falgarone, Bobigny)
11h00	TH17 and inflammation regulation (Glatigny , SQY)
14h00	Role of neutrophils in the mechanisms of inflammation and inflammation resolution (V Witko-Sarsat, Paris)
16h30	B lymphocyte in arthritis (G Nocturne, K Bicêtre)
Tuesday	Inflammation modulators
9h00	Signaling of microcrystalline inflammation (F Lioté, Paris)
11h00	Mastocytes and basophiles (N Thieblemont)
14h00	Macrophages and osteoimmunology (J Bouchet)
16h00	Liver inflammation and tumorigenesis (JC Nault, Bondy)
Wednesday	Tissue stress and inflammation
9h00	Periodontitis and bone resorption (M Gosset, Paris)
11h00	ACPA induction of arthritis: a new model of joint inflammation (S Bitoun, Londres/ KB)
14h00	Cell death and inflammation (Léa Tourneur, Paris)
16h00	TNF and anti-TNF strategy (L Semerano, Bobigny)
Thursday	Genetics and tissue inflammation
9h00	HLA-B27 transgenic rat model (M Breban, Boulogne-SQY)
11h00	Fibrosis and inflammation (J Avouac, Paris)
14h00	Inflammation imaging (G Renault, Paris)
16h30	Role of microbiota in chronic inflammatory rheumatic diseases (C Miceli, Paris)
Friday	9h00-12h00 : Exam

Program UE-4
Cartilage metainflammation and inflammaging

Contacts : Eric Haÿ, M. Biosse-Duplan, J. Bouchet, F. Rannou

Site : salle de cours, sous-sol du service de Rhumatologie, secteur violet – porte 4; Hôpital Lariboisière, 2 rue Ambroise Paré, 75010 Paris – Tel : 01 49 95 63 58

	Monday
10h00-12h00	Chondrocyte Maturation (Paris E. Haÿ, INSERM 1132, Université Paris Cité)
13h00-14h30	Glycosaminoglycan: matrix–cells interaction (Patricia Albanese, UPEC)
14h45-16h15	Origin and Fate of intervertebral disc (A. Camus, Nantes)
16h30-18h00	Hypoxia et development (S. Provot, Inserm U 1132, Université Paris Cité)
	Tuesday: pathologies
9h00-10h30	physiopathology of Osteoarthritis (F. Berenbaum, Sorbonne Université)
10h45-12h15	Cartilage and Aging Claire Vinatier ?
14h00-15h30	Cartilage metabolism (J. Sellam, Inserm UMR-938 / UPMC)
15h30-17h30	Debate: which target for osteoarthritis?
	Wednesday: integrated bone
9h00-10h30	Animal model for Osteoarthritis (H.K. Ea, INSERM U1132, Université Paris Cité)
10h45-12h15	Adipose tissue and Osteoarthritis (Xavier Houard)
14h00-15h30	Meckel Cartilage and maxilo facial developement (Martin Biosse-Duplan Université Paris Cité)
15h30-17h30	Debate: should we kill the chondrocyte?
	Thursday
9h00-10h30	Micro vesiculs (Blanc-Brude O, UP5)
10h45-12h15	Micro-RNA of chondrogenic cell (J. Lafont, CNRS UMR5086, Lyon)
14h00-15h30	Cartilage engineering (J. Guicheux, Nantes)
15h30-17h30	FGFR3 and pathology (L. Legeai-Mallet, Imagine, Université Paris Cité)
	Friday: imaging
9h00-10h30	Morphology and non invasive exploration technics (A.Pinzano, CNRS UMR7561, Université de Nancy)
10h45-12h15	Cartilage Biomarker's (Y. Henrotin, Belgique)
14h00-17h00	Exams/evaluations

Program UE-5
Biomaterials and Tissue engineering

Contacts : J. ISAAC, M. BENSIDHOUM, C. GORIN, C. NGUYEN

Sites: Garancière, ENSAM (Paris 13), Villemin

Monday	
09h00 09h15-10h45	<i>EU presentation and evaluation modalities</i> <i>“Introduction to biomaterials for health: proactivity, biomimetic interfacial & tridimensional properties”</i> (Pr. Emmanuel PAUTHE, ERRMECE, Université de Cergy Pontoise)
11h-12h30	<i>“Biomimetic materials in periodontal bone regeneration”</i> (Dr Juliane ISAAC, INSERM, UMRS-1138, Univ. Paris Diderot)
13h45-15h15	<i>“Laser assisted bioprinting: From cell to tissue engineering”</i> (Dr Adrien NAVEAU, INSERM U1026, Biotis, Univ. Bordeaux 2)
15h30-17h	<i>“Dental pulp engineering in pre-clinical models”</i> (Pr Sybille VITAL-OPSAHL, EA2496, Univ. Paris Descartes)
Tuesday	
09h-10h30 10h45 -12h15	<i>“Tissue and bone engineering”</i> (Dr Hervé PETITE, B3OA) <i>“Bone regeneration and osteoinduction”</i> (Dr Delphine LOGEART-AVRAMOGLU, B2OA, CNRS UMR-7052, Paris-Diderot)
14h-15h30 16h-17h30	<i>“Cardiovascular engineering”</i> (Dr Teresa SIMON-YARZA, INSERM, U1148, Lab Vascular Transl Sc.)
Wednesday	
09h00-10h30 10h45-12h15	<i>“Synthetic substitutes and tissue engineering matrices for ligament reconstruction”</i> (Dr Laurent CORTE, Mines-ParisTech, CNRS, UMR-7633) <i>“Cells in 2D versus 3D in bone engineering”</i> (Pr Joëlle AMÉDÉE, INSERM U1026, Biotis, Bordeaux 2)
14h00-15h30	<i>“From calcium phosphate-based bone substitutes to bone tissue engineering”</i> (Dr David MARCHAT, EMSE, Saint-Etienne)
Thursday	
09h00-10h30 10h30-12h	<i>“Angiogenesis and tissue engineering”</i> (L. MULLER, Collège de France) <i>“Cartilage engineering: biomaterials and stems cells”</i> (C. LE VISAGE, LIOAD, INSERM U791, Université de Nantes)
14h00-15h30 15h30-17h	<i>“Tracheal tissue engineering: from bench to bed side”</i> (E. MARTINOD, AP-HP) <i>“Mechanical stress signalization”</i> (F. RANNOU, INSERM 1124, Université Paris Cité)
Friday	
09h30-12h30	Tests/Exams

Program UE-6
Genetics and Pathophysiology

Contacts : C. Bardet, C. Collet, C. Gaucher, S. Houari

*Site : salle 201-202, 2^{ème} étage Faculté de Chirurgie Dentaire
1, rue Maurice Arnoux 92120 Montrouge*

Monday	Introduction and experimental research approaches
9:00am-10:30am	Introduction to genetics (C. Gaucher , EA 2496, Université Paris Cité)
10:45am-12:45pm	Cutting-edge facilities and platforms supporting scientific research: Genetic platforms / Biological Resource Center (C. Gaucher , EA 2496, Université Paris Cité)
2:00pm-4:00pm	Cutting-edge facilities and platforms supporting scientific research: Proteomic platforms (D. Lutomski , Université Paris 13)
4:15pm-6:15pm	Translational research: Regulations and guidelines for ethical practices in animal experimentation (C. Ferreira , Université Paris Cité)
Tuesday	From molecular understanding to clinical trials – part 1
9:00am-11:00am	Translational research: Cre-Lox system strategies (R. Kozyraki , O. Cases , CRC, INSERM U1138, Université Paris Cité)
11:15am-12:45pm	Genetic mechanisms in environmental exposures - Fluoride and Iron metabolism (S. Houari , CRC, INSERM U1138, Université Paris Cité)
2:00pm-4:00pm	Teeth anomalies and genetics (C. Bardet , EA 2496, Université Paris Cité)
4:15pm-5:45pm	Genetics and evolution (S. Delgado , UPMC)
6:00pm-6:30pm	Directed learning: presentation
Wednesday	From molecular understanding to clinical trials – part 2
9:00am-11:00am	Genetics of mineral homeostasis (P. Houillier , CRC, INSERM UMR_S1138, Université Paris Cité)
11:15am-1:15pm	Genetics and epigenetics of calcium and phosphate metabolic disorders (A. Molin , Université Caen Normandie, EA7450 BioTARGen)
2:00pm-4:00pm	Genetics of rare bone diseases (C. Collet , INSERM U1132, Université Paris Cité)
4:15pm-5:45pm	Directed learning: preparation
Thursday	Research and patients - example of rare diseases
9:00am-10:30am	Directed learning: oral restitution
10:45am-12:45pm	Interface between academic research / industry / patient: Consent, confidentiality, ethics (C. Bloch-Queyrat , Université Paris 13)
2:00pm-4:00pm	Patients and therapeutic applications: Rare bone diseases / Therapeutic trials (G. Baujat , Hôpital Necker-Enfants Malades)
4:15pm-5:45pm	Patients and clinical trials: BioMarin (Y. Fontes)
Friday	Research and patients - example of rare diseases
9:00am-10:00am	Interface between academic research / industry / patient: Industry and academic research (F. Gombert , SAT ERGANE0 ; O. Ollivier , Université Paris Cité)
10:15am-12:15pm	Interface between academic research / industry / patient: Clinical Research Unit and basic research strategies (E. Vicaud , URC Saint-Louis Lariboisière Fernand-Widal)
2:00pm-5:00pm	Exam

Program UE-7
Mineralization, Physiologic and heterotopic mineralization:
crystallization and cellular aspects

Contacts : C. Chaussain, A. Berdal, HK. EA.

*Site: meeting room of INSERM 1132, Department of Rheumatology, pink sector – Gate 4
Hôpital Lariboisière, 2 rue Ambroise Paré, 75010 Paris*

	Monday
10h00-12h00	Microcrystals in human diseases (Vincent Frochot, Hôpital Tenon)
14h00-15h30	Inherited mineralization diseases: genetic and metabolic aspects (A Lingart, Paris)
15h45-17h45	Crystallization, calcium crystal formation, in vitro models (Christèle Combes, école polytechnique, Toulouse)
	Tuesday
9h00-10h30	Methods of crystal characterization (Dominique Bazin, Orsay)
10h45-12h15	Metabolic and inflammation factors in kidney stones (E. Letavernier, Univ Paris 6)
14h00-15h30	Pseudoxanthoma elasticum: a model of systemic ectopic calcification (L. Martin, Angers)
15h45-17h15	Extracellular matrix and regulation of mineralization (M. McKee, Mc Gill)-cours online
	Wednesday
9h00-10h30	Calcium sensing receptor and calcifications (R. Mentaverri)
10h45-12h15	Microcrystal-induced inflammation (H.K. Ea)
14h00-15h30	Oro-facial ectopic mineralization (Renata Kozyraki, Inserm et Université Paris Cité)
15h30-17h30	Discussion: interactions calcification/host (Moderators R Kozyraki, A Berdal, Korng Ea)
	Thursday
9h00-10h30	Cellular differentiation in vascular calcifications (H. Kempf, CNRS Nancy)
10h45-12h15	Bone mineralization and biomechanic (P. Swider, Toulouse)
14h00-15h30	Ectopic mineralization : therapeutic approaches (P. Urena, Saint Ouen)
15h30-17h30	Discussion : calcification treatments (moderators Pablo Urena/ Korng Ea)
	Friday
9h00-12h00	Tests/Exams

Programmes basés sur l'année 2021-2022 qui pourraient être soumis à des modifications pour 2022/2023
Programs based on the year 2021-2022 that could be subject to changes for 2022/2023