In the human body, each tissue has its own extracellular matrix composition and stiffness and its unique tri-dimensional cell arrangement which makes growing ex-vivo tissues a challenge. Here we show that long term culture (month) within the core of a few hundred microns diameter, porous and scaffold-free, capsules under physiological conditions provides a solution. As one example we show how primary human hepatocytes reorganize inside hydrogel capsules and create a tri-dimensional spheroid by self-assembling over the first week post-encapsulation. Establishment of cell-cell interactions and extracellular matrix deposition lead to formation of micro-tissues that mimic physiological in vivo phenotypes. One attribute are bile canaliculi, an interconnected network playing the role of elimination of bile secreted by hepatocytes, which is perfectly established in our system contrary to 2D cultures. This morphological conformity to liver architecture is also reflected in the high liver-specific metabolic functions detected in our micro-tissues such as high cell viability (up to 45 days) and preservation, as well as a high and stable level of gene expression and enzymatic activity of major liver-specific metabolizing enzymes. We will finally discuss the various potential applications and uses of such technology.
Jerome Bibette, Ph.D. born July 8th 1960, french, is a Professor at Ecole Supérieure de Physique et Chimie Industrielles de la ville de Paris, (ESPCI), from 2001-present, and the Director of the Chemistry Biology Innovations Institute in ESPCI. Major research accomplishments include, i) invented the first route to prepare Brownian monodisperse emulsions, ii) and from these new colloids demonstrated various important interaction and phase transition mechanisms in colloidal science, iii) invented and develop the first technique to directly probe force distance profiles between colloidal particles, iv) developed a general understanding of metastability and coalescence of emulsions, v) developed tools for production as well as a general understanding of controlled emulsification by shear, and applied it to double emulsion and magnetic emulsion large scale preparation. vi) developed new magnetic colloids from emulsion and invented new techniques based on self assembling of these particles for DNA separation in microfluidic and ultra rapid proteins detection, vii) developed new techniques to probe single biocomplex elasticity and recognition rate, and evidenced the first microscopic swimming device from these structures, VIII) set the basis for creating colloidal isomers including double helix as DNA and more recently IX) opened routes for High throughput phenotypic screening in microbes populations as a basic tool to track radiation of species within evolving populations and finally IX) discovered mesoscopic structures in which human tissues can be grown and assayed. Honors and awards include Member of Institut Universitaire de France in 1994, and the Silver Medal of CNRS in Chemistry in 2000. About 130 papers, and 55 Patents, H index 41, founder of 11 companies among which Ademtech (France) in 2000, a biotech company specializing in the preparation of magnetic particles for diagnosis and molecular biology, Raindance Technologies (USA, MA) in 2004, a biotech company specializing in the digital microfluidic for high throughput screening, Capsum (France) in 2008 acquired by Chanel in 2015, a biotech company specializing in the capillary microfluidic for encapsulation and new visuals /formula in cosmetics, HiFiBiO in 2013, a biotech company devoted to antibodies drug discovery, Biomillenia in 2014 devoted to enzyme and microbial strains discovery and production, Millidrop Instrument in 2015 devoted to microbiology and life science instruments, and more recently Calyxia devoted to encapsulating actives and catalysts for large scale chemistry from oil industry to polymeric materials.