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Editorial
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Polymers at the Interface with Biology

Biology in its broadest sense is an important model and inspiration for science and technology. In relation to polymers, biology uses a variety of complex macromolecules to accomplish a myriad of functions in living systems. These biopolymers incorporate many unique features that have inspired the polymer community, including sequence specificity, renewable feedstocks, catalytic activity, self-replication, and specific recognition. Bioinspired synthetic and biologically derived polymers are critical components of many innovative solutions aimed at addressing some of the most pressing problems related to human health and the environment. Challenges and opportunities for the polymer science community at large include both developing synthetic strategies toward such materials as well as studying and developing a fundamental understanding of their interactions with biological systems. Since its inception in 2000, *Biomacromolecules* has strived to become the leading forum for the dissemination of cutting-edge research at the interface of polymer science and biology. Articles published in *Biomacromolecules* contain strong elements of innovation in terms of macromolecular design, synthesis, and characterization or in new applications of polymers to biology and medicine.

The aims of this Editorial are to review the evolution of research at the interface of polymer science and biology and to present a forward-looking view of this field. We do this by highlighting some areas of research that have been prominently featured in *Biomacromolecules* over the past years and by presenting some emerging topics that we consider of great relevance and interest to the polymer science community and the readership of *Biomacromolecules*. This Editorial is partly based on a symposium entitled "*Polymers at the Interface with Biology*" and an associated "round-table" discussion that took place during the 2017 American Chemical Society (ACS) Fall Meeting in Washington, DC. The participants of this discussion included the Editor-in-Chief and Associate Editors of *Biomacromolecules* as well as a group of 13 invited experts.

Research at the intersection of polymer science and biology has significantly evolved over the past two decades. To illustrate this, Table 1 provides a collection of the most highly cited manuscripts published in *Biomacromolecules* since the start of the journal in the year 2000. Table 1 only includes original research papers, i.e., no review articles. The table illustrates how the focus of many of the most cited papers in the field has gradually shifted over time. The focus of highly cited papers that appeared between 2000 and 2006 was heavily influenced by natural biopolymers (e.g., cellulose, silk) as well as electrospinning of polymer fibers. Other highly cited manuscripts that were published in *Biomacromolecules* during this period include seminal work on the development of reduction-sensitive block copolymer micelles,[12] the use of "click-type" conjugate addition reactions,[9,19] or DOPA chemistry[17] to produce functional hydrogel materials as well as the design of antibacterial surface films using surface-initiated controlled radical polymerization methods.[30] By comparison, many highly cited papers published in *Biomacromolecules* between 2007 and 2013 report on the preparation, characterization, and use of cellulose nanofibers. In addition, this era features work on the preparation of nonfouling polymer coatings[51] and also shows an increased interest in the design of pH and/or reduction-sensitive polymer nanocarriers for intracellular drug delivery[47,64,82,84] as well as further examples to explore the utilization of DOPA-based chemistries for the preparation of polymer nanoparticles,[68] microcapsules,[73] and hydrogels.[80] Highly cited work from the most recent period (2014−present day) includes a number of articles focused on the development of surfaces or scaffolds designed to enhance tissue regeneration or for cell culture.[88,89,91] Other examples include self-healing materials,[105] mussel-inspired pH responsive hydrogels,[87] investigation of how adsorbed proteins influence cellular uptake of nanoparticles,[92] and several studies on pH, redox, temperature, and light-responsive polymer particles designed to facilitate intracellular or intratumoral drug release.[86,90,94,100] Although the highly cited papers listed in Table 1 and highlighted above reflect topics that have generated significant interest, it is also important to recognize that they, of course, are not exclusively representative of the content published in *Biomacromolecules*. As is evident also from Table 1, research fields continuously evolve, and *Biomacromolecules* aims to capture new and exciting work at the forefront of the field.

One important objective of the "*Polymers at the Interface with Biology*" symposium was to develop a forward-looking view of the field and highlight emerging topics that are of particular interest to the readership of *Biomacromolecules*. Many interesting topics relevant to this theme were presented by the speakers at the symposium in Washington, DC. One example is the diverse field of biorelated synthetic polymers, which includes those based on natural biopolymers, such as polypeptides, polynucleic acids, and polysaccharides, as well as those that mimic nature, including polypeptoids and other peptidomimetics, polymers from biological feedstocks, and sequence-controlled polymers.

For the field of biosourced sustainable polymers, Prof. Eugene Chen discussed and emphasized the importance of enhancing the thermal and mechanical properties of bioderived synthetic polyesters and also realizing the potential to chemically recycle these polymers back to their constituent monomers. He reported catalytic systems capable of preparing such polyesters with enhanced properties via ring-opening polymerization of γ-butyrolactone and its derivatives, as well as the methodology that permits their complete depolymerization back to the original building blocks.[109−111] Polymers containing functional side-chains and possessing the ability to respond to different stimuli continue to be developed as functional and structural mimics of biological polymers and assemblies. Related to this theme, Prof. Steven Armes presented the synthesis of pH-responsive triblock copolymers

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Table 1. Overview of Highly Cited Original Research Papers Published in *Biomacromolecules* Since 2000

Manuscript title	Authors	Year	Ref.
Structural and Rheological Properties of Methacrylamide Modified Gelatin Hydrogels	Van den Bulcke, AI; Bogdanov, B; De Rooze, N; Schacht, EH; Cornelissen, M; Berghmans, H	2000	1
Quaternary Ammonium Functionalized Poly(propylene imine) Dendrimers as Effective Antimicrobials: Structure-Activity Studies	Chen, CZ; Beck-Tan, NC; Dhurjati, P; van Dyk, TK; LaRossa, RA; Cooper, SL	2000	2
New Insight Into Agarose Gel Mechanical Properties	Normand, V; Lootens, DL; Amici, E; Plucknett, KP; Aymard, P	2000	3
Multifunctional Epoxy Supports: A New Tool To Improve the Covalent Immobilization of Proteins. The Promotion of Physical Adsorptions of Proteins on the Supports before Their Covalent Linkage	Mateo, C; Fernández-Lorente, G; Abian, O; Fernández-Lafuente, R; Guisán, JM	2000	4
Periodate Oxidation of Crystalline Cellulose	Kim, UJ; Kuga, S; Wada, M; Okano, T; Kondo, T	2000	5
Candida antartica Lipase B Catalyzed Polycaprolactone Synthesis: Effects of Organic Media and Temperature	Kumar, A; Gross, RA	2000	6
Molecular Basis of Ca^{2+}-Induced Gelation in Alginates and Pectins: The Egg-Box Model Revisited	Braccini, I; Pérez, S	2001	7
Relation between the Degree of Acetylation and the Electrostatic Properties of Chitin and Chitosan	Sorlier, P; Denuzière, A; Viton, C; Domard, A	2001	8
Conjugate Addition Reactions Combined with Free-Radical Cross-Linking for the Design of Materials for Tissue Engineering	Elbert, DL; Hubbell, JA	2001	9
X-ray Structure of Mercerized Cellulose II at 1 Å Resolution	Langan, P; Nishiyama, Y; Chanzy, H	2001	10
Mechanisms and Kinetics of Thermal Degradation of Poly(ε-caprolactone)	Persenaire, O; Alexandre, M; Degée, P; Dubois, P	2001	11
Glutathione-Sensitive Stabilization of Block Copolymer Micelles Composed of Antisense DNA and Thiolated Poly(ethylene glycol)-block-poly(L-lysine)	Kakizawa, Y; Harada, A; Kataoka, K	2001	12
Electrospinning of Collagen Nanofibers	Matthews, JA; Wnek, GE; Simpson, DG; Bowlin, GL	2002	13
Electrospinning *Bombyx mori* Silk with Poly(ethylene oxide)	Jin, HJ; Fridrikh, SV; Rutledge, GC; Kaplan, DL	2002	14
Disulfide Cross-Linked Hyaluronan Hydrogels	Shu, XZ; Liu, Y; Luo, Y; Roberts, MC; Prestwich, GD	2002	15
Genetically Encoded Synthesis of Protein-Based Polymers with Precisely Specified Molecular Weight and Sequence by Recursive Directional Ligation: Examples from the Elastin-like Polypeptide System	Meyer, DE; Chilkoti, A	2002	16
Synthesis and Gelation of DOPA-Modified Poly(ethylene glycol) Hydrogels	Lee, BP; Dalsin, JL; Messersmith, PB	2002	17
Surface Modification of Polycaprolactone Membrane via Aminolysis and Biomacromolecule Immobilization for Promoting Cytocompatibility of Human Endothelial Cells	Zhu, Y; Gao, C; Liu, X; Shen, J	2002	18
Synthesis and Physicochemical Characterization of End-Linked Poly(ethylene glycol)-*co*-peptide Hydrogels Formed by Michael-Type Addition.	Lutolf, MP; Hubbell, JA	2003	19
Rational Design of Cytophilic and Cytophobic Polyelectrolyte Multilayer Thin Films	Mendelsohn, JD; Yang, SY; Hiller, J; Hochbaum, AI; Rubner, MF	2003	20
Complex Coacervation of Whey Proteins and Gum Arabic	Weinbreck, F; de Vries, R; Schrooyen, P; de Kruif, CG	2003	21
Ionic Strength Dependence of Protein-Polyelectrolyte Interactions	Seyrek, E; Dubin, PL; Tribet, C; Gamble, EA	2003	22
Bioactive Coatings of Endovascular Stents Based on Polyelectrolyte Multilayers	Thierry, B; Winnik, FM; Merhi, Y; Silver, J; Tabrizian, M	2003	23
Synthesis and Characterization of Injectable Poly(*N*-isopropylacrylamide-*co*-acrylic acid) Hydrogels with Proteolytically Degradable Cross-Links	Kim, S; Healy, KE	2003	24
Porous 3-D Scaffolds from Regenerated Silk Fibroin.	Nazarov, R; Jin, HJ; Kaplan, DL	2004	25
Effect of Sulfate Groups from Sulfuric Acid Hydrolysis on the Thermal Degradation Behavior of Bacterial Cellulose	Roman, M; Winter, WT	2004	26
Homogeneous Acetylation of Cellulose in a New Ionic Liquid	Wu, J; Zhang, J; Zhang, H; He, J; Ren, Q; Guo, M	2004	27
TEMPO-Mediated Oxidation of Native Cellulose. The Effect of	Saito, T; Isogai, A	2004	28

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Table 1. continued

Oxidation Conditions on Chemical and Crystal Structures of the Water-Insoluble Fractions			
Structure and Properties of Silk Hydrogels	Kim, UJ; Park, JY; Li, C; Jin, HJ; Valluzzi, R; Kaplan, DL	2004	29
Permanent, Nonleaching Antibacterial Surfaces. 1. Synthesis by Atom Transfer Radical Polymerization	Lee, SB; Koepsel, RR; Morley, SW; Matyjaszewski, K; Sun, Y; Russell, AJ	2004	30
Effect of Reaction Conditions on the Properties and Behavior of Wood Cellulose Nanocrystal Suspensions	Beck-Candanedo, S; Roman, M; Gray, DG	2005	31
Elastic Modulus and Stress-Transfer Properties of Tunicate Cellulose Whiskers	Šturcová, A; Davies, GR; Eichhorn, SJ	2005	32
Sustained Release of Proteins from Electrospun Biodegradable Fibers	Chew, SY; Wen, J; Yim, EKF; Leong, KW	2005	33
Controlled Degradation and Mechanical Behavior of Photopolymerized Hyaluronic Acid Networks	Burdick, JA; Chung, C; Jia, X; Randolph, MA; Langer, R	2005	34
Preparation and Mechanical Properties of Chitosan/Carbon Nanotubes Composites	Wang, SF; Shen, L; Zhang, WD; Tong, YJ	2005	35
Characterization of the Surface Biocompatibility of the Electrospun PCL-Collagen Nanofibers Using Fibroblasts	Zhang, YZ; Venugopal, J; Huang, ZM; Lim, CT; Ramakrishna, S	2005	36
Homogeneous Suspensions of Individualized Microfibrils from TEMPO-Catalyzed Oxidation of Native Cellulose	Saito, T; Nishiyama, Y; Putaux, JL; Vignon, M; Isogai, A	2006	37
Electrospun Poly(ε-caprolactone) Microfiber and Multilayer Nanofiber/Microfiber Scaffolds: Characterization of Scaffolds and Measurement of Cellular Infiltration	Pham, QP; Sharma, U; Mikos, AG	2006	38
Study of Biodegradable Polylactide/Poly(butylene adipate-*co*-terephthalate) Blends	Jiang, L; Wolcott, MP; Zhang, J	2006	39
PAMAM Dendrimer-Based Multifunctional Conjugate for Cancer Therapy: Synthesis, Characterization, and Functionality	Majoros, IJ; Myc, A; Thomas, T; Mehta, CB; Baker, JR	2006	40
Coaxial Electrospinning of (Fluorescein Isothiocyanate-Conjugated Bovine Serum Albumin)-Encapsulated Poly(ε-caprolactone) Nanofibers for Sustained Release	Zhang, YZ; Wang, X; Feng, Y; Li, J; Lim, CT; Ramakrishna, S	2006	41
Superior Solubility of Polysaccharides in Low Viscosity, Polar, and Halogen-Free 1,3-Dialkylimidazolium Formates	Fukaya, Y; Sugimoto, A; Ohno, H	2006	42
Enzymatic Hydrolysis Combined with Mechanical Shearing and High-Pressure Homogenization for Nanoscale Cellulose Fibrils and Strong Gels	Pääkö, M; Ankerfors, M; Kosonen, H; Nykänen, A; Ahola, S; Österberg, M; Ruokolainen, J; Laine, J; Larsson, PT; Ikkala, O; Lindström, T	2007	43
Cellulose Nanofibers Prepared by TEMPO-Mediated Oxidation of Native Cellulose	Saito, T; Kimura, S; Nishiyama, Y; Isogai, A	2007	44
Interactions between Alginate and Chitosan Biopolymers Characterized Using FTIR and XPS	Lawrie, G; Keen, I; Drew, B; Chandler-Temple, A; Rintoul, L; Fredericks, P; Grøndahl, L	2007	45
Obtaining Cellulose Nanofibers with a Uniform Width of 15 nm from Wood	Abe, K; Iwamoto, S; Yano, H	2007	46
PEG-SS-PPS: Reduction-Sensitive Disulfide Block Copolymer Vesicles for Intracellular Drug Delivery	Cerritelli, S; Velluto, D; Hubbell, JA	2007	47
New Nanocomposite Materials Reinforced with Flax Cellulose Nanocrystals in Waterborne Polyurethane	Cao, X; Dong, H; Li, CM	2007	48
Cellulose Nanopaper Structures of High Toughness	Henriksson, M; Berglund, LA; Isaksson, P; Lindström, T; Nishino, T	2008	49
The Shape and Size Distribution of Crystalline Nanoparticles Prepared by Acid Hydrolysis of Native Cellulose	Elazzouzi-Hafraoui, S; Nishiyama, Y; Putaux, JL; Heux, L; Dubreuil, F; Rochas, C	2008	50
Zwitterionic Polymers Exhibiting High Resistance to Nonspecific Protein Adsorption from Human Serum and Plasma	Ladd, J; Zhang, Z; Chen, S; Hower, JC; Jiang, S	2008	51
Fluorescence Study of the Curcumin-Casein Micelle Complexation and Its Application as a Drug Nanocarrier to Cancer Cells	Sahu, A; Kasoju, N; Bora, U	2008	52
Interaction of β-Lactoglobulin with Resveratrol and its Biological Implications	Liang, L; Tajmir-Riahi, HA; Subirade, M	2008	53
The Effect of Hemicelluloses on Wood Pulp Nanofibrillation and Nanofiber Network Characteristics	Iwamoto, S; Abe, K; Yano, H	2008	54
Transparent and High Gas Barrier Films of Cellulose Nanofibers Prepared by TEMPO-Mediated Oxidation	Fukuzumi, H; Saito, T; Iwata, T; Kumamoto, Y; Isogai, A	2009	55
Cellulose Whiskers versus Microfibrils: Influence of the Nature of the Nanoparticle and its Surface Functionalization on the Thermal	Siqueira, G; Bras, J; Dufresne, A	2009	56

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Table 1. continued

and Mechanical Properties of Nanocomposites			
Individualization of Nano-Sized Plant Cellulose Fibrils by Direct Surface Carboxylation Using TEMPO Catalyst under Neutral Conditions	Saito, T; Hirota, M; Tamura, N; Kimura, S; Fukuzumi, H; Heux, L; Isogai, A	2009	57
Elastic Modulus of Single Cellulose Microfibrils from Tunicate Measured by Atomic Force Microscopy	Iwamoto, S; Kai, W; Isogai, A; Iwata, T	2009	58
Investigation of the Interaction between Berberine and Human Serum Albumin	Hu, YJ; Liu, Y; Xiao, XH	2009	59
Non-cytotoxic Silver Nanoparticle-Polysaccharide Nanocomposites with Antimicrobial Activity	Travan, A; Pelillo, C; Donati, I; Marsich, E; Benincasa, M; Scarpa, T; Semeraro, S; Turco, G; Gennaro, R; Paoletti, S	2009	60
Fabrication, Mechanical Properties, and Biocompatibility of Graphene-Reinforced Chitosan Composites	Fan, H; Wang, L; Zhao, K; Li, N; Shi, Z; Ge, Z; Jin, Z	2010	61
Cytocompatibility and Uptake of Halloysite Clay Nanotubes	Vergaro, V; Abdullayev, E; Lvov, YM; Zeitoun, A; Cingolani, R; Rinaldi, R; Leporatti, S	2010	62
Nanofiber Composites of Polyvinyl Alcohol and Cellulose Nanocrystals: Manufacture and Characterization	Peresin, MS; Habibi, Y; Zoppe, JO; Pawlak, JJ; Rojas, OJ	2010	63
Shell-Sheddable Micelles Based on Dextran-SS-Poly(ε-caprolactone) Diblock Copolymer for Efficient Intracellular Release of Doxorubicin	Sun, H; Guo, B; Li, X; Cheng, R; Meng, F; Liu, H; Zhong, Z	2010	64
Fast Preparation Procedure for Large, Flat Cellulose and Cellulose/Inorganic Nanopaper Structures	Sehaqui, H; Liu, A; Zhou, Q; Berglund, LA	2010	65
Entire Surface Oxidation of Various Cellulose Microfibrils by TEMPO-Mediated Oxidation	Okita, Y; Saito, T; Isogai, A	2010	66
Transition of Cellulose Crystalline Structure and Surface Morphology of Biomass as a Function of Ionic Liquid Pretreatment and Its Relation to Enzymatic Hydrolysis	Cheng, G; Varanasi, P; Li, C; Liu, H; Menichenko, YB; Simmons, BA; Kent, MS; Singh, S	2011	67
Bioinspired Polymerization of Dopamine to Generate Melanin-Like Nanoparticles Having an Excellent Free-Radical-Scavenging Property	Ju, KY; Lee, Y; Lee, S; Park, SB; Lee, JK	2011	68
Strong and Tough Cellulose Nanopaper with High Specific Surface Area and Porosity	Sehaqui, H; Zhou, Q; Ikkala, O; Berglund, LA	2011	69
Synthesis of Multiresponsive and Dynamic Chitosan-Based Hydrogels for Controlled Release of Bioactive Molecules	Zhang, Y; Tao, L; Li, S; Wei, Y	2011	70
Surface Charge Affects Cellular Uptake and Intracellular Trafficking of Chitosan-Based Nanoparticles	Yue, ZG; Wei, W; Lv, PP; Yue, H; Wang, LY; Su, ZG; Ma, GH	2011	71
Clay Nanopaper with Tough Cellulose Nanofiber Matrix for Fire Retardancy and Gas Barrier Functions	Liu, A; Walther, A; Ikkala, O; Belova, L; Berglund, LA	2011	72
Immobilization and Intracellular Delivery of an Anticancer Drug Using Mussel-Inspired Polydopamine Capsules	Cui, J; Yan, Y; Such, GK; Liang, K; Ochs, CJ; Postma, A; Caruso, F	2012	73
Relationship between Length and Degree of Polymerization of TEMPO-Oxidized Cellulose Nanofibrils	Shinoda, R; Saito, T; Okita, Y; Isogai, A	2012	74
Modulation of Cellulose Nanocrystals Amphiphilic Properties to Stabilize Oil/Water Interface	Kalashnikova, I; Bizot, H; Cathala, B; Capron, I	2012	75
Ultrastrong and High Gas-Barrier Nanocellulose/Clay-Layered Composites	Wu, CN; Saito, T; Fujisawa, S; Fukuzumi, H; Isogai, A	2012	76
Photoresponsive Poly(S-(o-nitrobenzyl)-L-cysteine)-b-PEO from a L-Cysteine N-Carboxyanhydride Monomer: Synthesis, Self-Assembly, and Phototriggered Drug Release	Liu, G; Dong, CM	2012	77
Transparent Films Based on PLA and Montmorillonite with Tunable Oxygen Barrier Properties	Svagan, AJ; Akesson, A; Cárdenas, M; Bulut, S; Knudsen, JC; Risbo, J; Plackett, D	2012	78
An Ultrastrong Nanofibrillar Biomaterial: The Strength of Single Cellulose Nanofibrils Revealed via Sonication-Induced Fragmentation	Saito, T; Kuramae, R; Wohlert, J; Berglund, LA; Isogai, A	2013	79
Self-Healing Mussel-Inspired Multi-pH-Responsive Hydrogels	Krogsgaard, M; Behrens, MA; Pedersen, JS; Birkedal, H	2013	80
Self-Assembling Behavior of Cellulose Nanoparticles during Freeze-Drying: Effect of Suspension Concentration, Particle Size, Crystal Structure, and Surface Charge	Han, J; Zhou, C; Wu, Y; Liu, F; Wu, Q	2013	81
Redox-Responsive, Core-Cross-Linked Micelles Capable of On-Demand, Concurrent Drug Release and Structure Disassembly	Wang, H; Tang, L; Tu, C; Song, Z; Yin, Q; Yin, L; Zhang, Z; Cheng, J	2013	82
Isolation of Thermally Stable Cellulose Nanocrystals by Phosphoric	Espinosa, SC; Kuhnt, T; Foster,	2013	83

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Table 1. continued

Acid Hydrolysis	EJ; Weder, C		
pH-Triggered Charge-Reversal Polypeptide Nanoparticles for Cisplatin Delivery: Preparation and In Vitro Evaluation	Huang, Y; Tang, Z; Zhang, X; Yu, H; Sun, H; Pang, X; Chen, X	2013	84
Dual Responsive Pickering Emulsion Stabilized by Poly[2-(dimethylamino)ethyl methacrylate] Grafted Cellulose Nanocrystals	Tang, J; Lee, MFX; Zhang, W; Zhao, B; Berry, RM; Tam, KC	2014	85
Light-Responsive Micelles of Spiropyran Initiated Hyperbranched Polyglycerol for Smart Drug Delivery	Son, S; Shin, E; Kim, BS	2014	86
Mussel-Mimetic Protein-Based Adhesive Hydrogel	Kim, BJ; Oh, DX; Kim, S; Seo, JH; Hwang, DS; Masic, A; Han, DK; Cha, HJ	2014	87
Electrically Conductive Chitosan/Carbon Scaffolds for Cardiac Tissue Engineering	Martins, AM; Eng, G; Caridade, SG; Mano, JF; Reis, RL; Vunjak-Novakovic, G	2014	88
Aerogel Microspheres from Natural Cellulose Nanofibrils and Their Application as Cell Culture Scaffold	Cai, H; Sharma, S; Liu, W; Mu, W; Liu, W; Zhang, X; Deng, Y	2014	89
PEG-b-PCL Copolymer Micelles with the Ability of pH-Controlled Negative-to-Positive Charge Reversal for Intracellular Delivery of Doxorubicin	Deng, H; Liu, J; Zhao, X; Zhang, Y; Liu, J; Xu, S; Deng, L; Dong, A; Zhang, J	2014	90
3D Bioprinting Human Chondrocytes with Nanocellulose-Alginate Bioink for Cartilage Tissue Engineering Applications	Markstedt, K; Mantas, A; Tournier, I; Ávila, HM; Hägg, D; Gatenholm, P	2015	91
Protein Corona of Nanoparticles: Distinct Proteins Regulate the Cellular Uptake	Ritz, S; Schöttler, S; Kotman, N; Baier, G; Musyanovych, A; Kuharev, J; Landfester, K; Schild, H; Jahn, O; Tenzer, S; Mailänder, V	2015	92
Thermogelling Polymer-Platinum(IV) Conjugates for Long-Term Delivery of Cisplatin	Shen, W; Luan, J; Cao, L; Sun, J; Yu, L; Ding, J	2015	93
Bioreducible Shell-Cross-Linked Hyaluronic Acid Nanoparticles for Tumor-Targeted Drug Delivery	Han, HS; Thambi, T; Choi, KY; Son, S; Ko, H; Lee, MC; Jo, DG; Chae, YS; Kang, YM; Lee, JY; Park, JH	2015	94
Tea Stains-Inspired Initiator Primer for Surface Grafting of Antifouling and Antimicrobial Polymer Brush Coatings	Pranantyo, D; Xu, LQ; Neoh, KG; Kang, ET; Ng, YX; Teo, SLM	2015	95
Grafting of Bacterial Polyhydroxybutyrate (PHB) onto Cellulose via In Situ Reactive Extrusion with Dicumyl Peroxide	Wei, L; McDonald, AG; Stark, NM	2015	96
In Situ Synthesis of Antimicrobial Silver Nanoparticles within Antifouling Zwitterionic Hydrogels by Catecholic Redox Chemistry for Wound Healing Application	GhavamiNejad, A; Park, CH; Kim, CS	2016	97
Halloysite Clay Nanotubes for Enzyme Immobilization	Tully, J; Yendluri, R; Lvov, Y	2016	98
Structural Description of the Interface of Pickering Emulsions Stabilized by Cellulose Nanocrystals	Cherhal, F; Cousin, F; Capron, I	2016	99
Facile Construction of pH- and Redox-Responsive Micelles from a Biodegradable Poly(β-hydroxyl amine) for Drug Delivery	Li, D; Bu, Y; Zhang, L; Wang, X; Yang, Y; Zhuang, Y; Yang, F; Shen, H; Wu, D	2016	100
Enhanced Mechanical Properties in Cellulose Nanocrystal–Poly(oligoethylene glycol methacrylate) Injectable Nanocomposite Hydrogels through Control of Physical and Chemical Cross-Linking	De France, KJ; Chan, KJW; Cranston, ED; Hoare, T	2016	101
Optically Transparent Wood from a Nanoporous Cellulosic Template: Combining Functional and Structural Performance	Li, Y; Fu, Q; Yu, S; Yan, M; Berglund, L	2016	102
Highly Efficient Supramolecular Aggregation-Induced Emission-Active Pseudorotaxane Luminogen for Functional Bioimaging	Liow, SS; Zhou, H; Sugiarto, S; Guo, S; Chalasani, MLS; Verma, NK; Xu, J; Loh, XJ	2017	103
Amphiphilic and Hydrophilic Block Copolymers from Aliphatic *N*-Substituted 8-Membered Cyclic Carbonates: A Versatile Macromolecular Platform for Biomedical Applications	Venkataraman, S; Tan, JPK; Ng, VWL; Tan, EWP; Hedrick, JL; Yang, YY	2017	104
Facile Access to Multisensitive and Self-Healing Hydrogels with Reversible and Dynamic Boronic Ester and Disulfide Linkages	Guo, R; Su, Q; Zhang, J; Dong, A; Lin, C; Zhang, J	2017	105
Controlling Self-Assembling Peptide Hydrogel Properties through Network Topology	Gao, J; Tang, C; Elsawy, MA; Smith, AM; Miller, AF; Saiani, A	2017	106
Polyvalent Folate-Dendrimer-Coated Iron Oxide Theranostic Nanoparticles for Simultaneous Magnetic Resonance Imaging and Precise Cancer Cell Targeting	Luong, D; Sau, S; Kesharwani, P; Iyer, AK	2017	107
Effects of Xylan Side-Chain Substitutions on Xylan–Cellulose Interactions and Implications for Thermal Pretreatment of Cellulosic Biomass	Pereira, CS; Silveira, RL; Dupree, P; Skaf, MS	2017	108

designed to self-assemble into framboidal vesicles that were capable of mimicking the structural features and pH-triggered morphological transitions of certain viruses, e.g., the Dengue virus.

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Engineered biorelated polymers, such as recombinant proteins and polymers produced using biocatalysis, are another core area for *Biomacromolecules*. In the symposium, Prof. Jan van Hest described engineered chimeric proteins composed of elastin-like segments and cowpea chlorotic mottle virus subunits and their assembly into nanostructures that form biomimetic structures capable of responding to pH, temperature, and salt. These assemblies take advantage of the stimuli-responsive properties of elastin sequences, and the precision subunit assembly features of viral proteins.[112−114] Related to this theme, Prof. Julie Champion discussed the design and preparation of protein constructs containing segments composed of coiled-coil and antibody binding motifs that enable them to assemble into well-defined nanostructures capable of binding and presenting antibodies. These nanocarriers are being evaluated for the intracellular delivery of therapeutic antibodies.[115]

Beyond synthesis and structure, understanding the properties and dynamics of biorelated polymer assemblies is also central to the scope of *Biomacromolecules*. Prof. Monica Olvera de la Cruz studies how multivalent ions and polymers can interact with amphiphilic molecules to form different morphologies with diverse chemical functionality.[116−119] Modeling of such systems can lead to the discovery of new functional structures that can mimic biological functions. In studies aimed at mimicking coacervate formation observed with intrinsically disordered proteins in membraneless organelles within cells, Prof. Matthew Tirrell presented studies on complex coacervation of oppositely charged synthetic polyelectrolytes where a variety of features, including polymer stereochemistry, polymer chain length, and solution ionic strength were found to influence polyelectrolyte complex phase separation.[120] These insights into protein/polyelectrolyte complexation show promise for the design of new biomimetic materials.[121]

An obstacle that presents a significant hurdle toward the clinical implementation of polymers and polymer-based nanomaterials for drug delivery applications is a lack of reproducible and scalable synthetic protocols. Polymer nanoparticles, as an example, are typically obtained via multiple formulation and modification steps. To overcome these challenges, Prof. Jeremiah Johnson described the preparation of macromolecular prodrugs starting from complex, small building blocks, which are accessible via organic synthesis.[122−125] These small building blocks are then assembled together, for example, using ring-opening metathesis polymerization (ROMP), into the desired nanomaterial, thereby decoupling synthetic complexity and scalability.

Polymers and polymer nanoparticles are widely acknowledged for their ability to prolong the blood circulation time of therapeutics and to facilitate targeted delivery (e.g., to a tumor in cancer therapy). In addition to controlling plasma half-life and enabling targeted delivery of therapeutics, another pressing problem, in particular for biologics (such as peptide-, protein-, or nucleotide-based actives), is their stability during shipping and storage.[126] This is a fundamental research problem, yet one with enormous impact in those parts of the world where an effective and reliable cold chain from the manufacturer to the patient is absent. Addressing this challenge, Prof. Heather Maynard emphasized the need for improved polymers for protein stabilization, especially for prolonged storage, and presented functional polymer designs, some also degradable, that enabled protein protection to heat and mechanical agitation. The polymers could be conjugated to proteins and peptides, added as excipients, or used to surround the biologic as a nanoparticle for potential use in medicine.[127−133]

Considerable research over the past few decades has accumulated an increasingly robust understanding of the behavior of polymers and polymer nanoparticles in blood circulation as well as mechanisms for their cellular uptake. Fundamental design principles to control properties such as plasma half-life or to promote cellular internalization have been established for the preparation of more effective polymer nanomedicines. However, because the target for many active compounds is a specific cellular organelle, understanding and controlling the behavior of polymer nanomedicines at the subcellular level remains an important challenge. Aimed at addressing this issue, Prof. Millicent Sullivan and co-workers developed light-sensitive mPEG-*b*-poly(5-(3-(amino)-propoxy)-2-nitrobenzyl methacrylate) polymers to deploy nucleic acids into cells with "on/off" control over the timing and amount of delivery and spatial control at cellular length scales.[134−138]

In addition to their utility for drug delivery, polymers and polymer assemblies also possess great potential for use in the broad realm of immunotherapy, including the targeted delivery of immunomodulatory drugs or vaccines to lymphoid organs or tumors. Prof. Darrell Irvine presented the use of polymer-based amphiphiles to increase the safety and potency of immunotherapies. Initially, these polymer amphiphiles were used to bind antigens and adjuvants to albumin.[139,140] Next, these amphiphiles were designed to associate with a stimulator of interferon genes (STING) agonist and assemble into nanofibers or nanodiscs that may be administered locally or systemically. Another strategy that underlines the potential of polymer science to advance immunotherapy was presented by Prof. Laura Kiessling, who described polymers that target antigens to dendritic cells.[141] These polymers exploit the features of lectins, which are important for the recognition, uptake, and processing of antigens.[142] She reported that the fate of glycosylated antigens in dendritic cells is affected by their physical properties (e.g., size, length), which can be altered using controlled polymerization techniques. These parameters define how polymers can be used to deliver antigens to dendritic cells to avoid immune detection or to promote immunity.

In addition to the diagnosis and treatment of human diseases, another important medical application for polymer-based materials is in the repair or regeneration of damaged or lost tissue. A particularly challenging problem in this context is bone defect generation because it requires polymers that are exceptionally strong and at the same time can also degrade at designed intervals. Prof. Matthew Becker presented a class of α-amino acid based poly(ester urea)s (PEUs) that were designed for this purpose.[143] One of the keys to the successful development of these materials was optimized step polymerization protocols and functionalization strategies, which afforded high molecular weight materials and provided excellent synthetic flexibility.[144] In sheep segmental tibia defect models, the use of scaffolds fabricated from these PEU polymers allowed near complete defect healing within 16 weeks.

Minimally invasive soft tissue regeneration demands hydrogels that provide mechanical protection to cells during injection that are also able to adapt to accommodate local cell remodeling of the polymer network.[145,146] One approach

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toward such materials was presented by Prof. Sarah Heilshorn who described a new class of double-network hydrogels. Prior to injection, these materials are cross-linked ex situ by the formation of dynamic covalent hydrazone bonds that result from mixing a hydrazine-modified elastin-like polypeptide (ELP) and an aldehyde-modified hyaluronic acid. In situ, after injection, thermoresponsive aggregation of the ELP reinforces the network resulting in a hydrogel matrix that possesses viscoelastic stress-relaxation behavior.[147]

These topics presented in Washington, DC highlight some of the research directions at the forefront of polymer science and biology and represent areas and communities *Biomacromolecules* aims to serve. These fields are dynamic: new synthetic methodologies are being developed; more accurate characterization tools become available, and biology moves to smaller and smaller length-scales and becomes more quantitative. With these changes, and as new important societal challenges arise, *Biomacromolecules* endeavors to adapt to include emerging themes and scientific breakthroughs at the interface of polymer science and biology.

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