

## Marshall R. Urist, 1914–2001

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**Abstract** This biographical sketch of Marshall R. Urist corresponds to the historic texts, *The Classic: Bone Morphogenetic Protein*, available at DOI [10.1007/s11999-009-1068-3](https://doi.org/10.1007/s11999-009-1068-3); *The Classic: A Morphogenetic Matrix for Differentiation of Cartilage in Tissue Culture*, available at DOI [10.1007/s11999-009-1069-2](https://doi.org/10.1007/s11999-009-1069-2); and *The Classic: A Morphogenetic Matrix for Differentiation of Bone Tissue*, available at DOI [10.1007/s11999-009-1070-9](https://doi.org/10.1007/s11999-009-1070-9).

Dr. Marshall R. Urist (Fig. 1) was born in Chicago, but raised in rural Michigan [6]. He obtained his undergraduate degree in science at the University of Michigan in 1936 and a Master of Science degree at the University of Chicago in 1937. He subsequently attended the Johns Hopkins Medical School, where he graduated in 1941. He began a residency at the Children's Hospital in Baltimore, but enlisted in the US Army in 1943. Urist was eventually assigned to England, and then to the 97th General Hospital in Germany. In 1946 he returned to the States to the Surgeon General's office where he was assigned to record the advances made during World War II in treating open fractures. After resigning his Army commission he completed residency training at the Massachusetts General Hospital and Boston Children's Hospital. He returned to the University of Chicago in 1947. There he met Dr. Franklin Chambers McLean (1888–1968), a well-known physiologist, who became his mentor (see 50 Years Ago in CORR for an article by McLean published in an early issue

of CORR [4]). McLean and Urist collaborated on a series of papers on bone growth beginning in 1948 (three of which are exemplified by [12–14]).

Dr. Urist had a long, brilliant, and distinguished career, publishing in many basic and clinical areas but focusing on bone repair, one of his earliest interests (PubMed alone lists 486 articles). He won numerous awards for his work, among them the Kappa Delta Award of the American Academy of Orthopaedic Surgeons, the Claude Bernard Medal, and a John Simon Guggenheim Foundation Fellowship [6]. He received an honorary degree in medicine from the University of Lund and honorary fellowship in the Royal College of Surgeons, Edinburgh. He was long an active member of the Association of Bone and Joint



**Fig. 1** Dr. Marshall Urist is shown. (Photograph reprinted with permission of the Urist family.)

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Surgeons (ABJS). Awards in his name are given annually by the Orthopaedic Research Society and the ABJS.

In 1966 on the retirement of Dr. Anthony DePalma [3] the ABJS offered and Dr. Urist accepted the editorship of *Clinical Orthopaedics and Related Research*, a post he held until 1993. Dr. Urist continued two key features of CORR instituted by his predecessor: a monthly symposium devoted to a single topic and *The Classic*. In the late 1980s, he forged affiliations with two important societies that did not have their own journals: The Hip Society and The Knee Society.

This month's symposium is a tribute to Dr. Urist's insight, creativity, and tenacity to explore the mechanisms of bone growth, development, and repair. In particular, based on bone extracts he discovered a "morphogenetic property" [11] of decalcified bone matrix which acted as a growth factor to stimulate bone formation in a variety of tissues (eg, subcutaneous tissue, brain, spinal cord, tendon, peritoneum) but not others (eg, thyroid, thymus, spleen, liver, kidney). Growth factors had been known for decades: in the late 18th century the term was occasionally used in the botany literature to describe external factors (eg, light, soil nutrients) contributing to growth, but in the 1920s and 1930s was applied in its more current sense as intrinsic tissue factors important for biological processes [7, 16]. The advances in molecular biology in the 80s and early 90s allowed the sequencing and cloning of bone morphogenetic proteins [5, 8], which in fact turned out to be a family of proteins that were part of a larger superfamily of growth factors originally reported as transforming growth factor-beta (TGF- $\beta$ ) [2]. (Transforming growth factors, originally described in 1981 [9] were distinguished as alpha and beta families in 1982 [1].) The articles we reproduce here were his earliest on bone morphogenetic protein or BMP [10, 11, 15], undoubtedly his most important discovery and one that has resulted in thousands of basic and clinical studies (PubMed lists over 12,000, 229 of which appear in *Clinical Orthopaedics and Related Research*), and FDA approved applications. In the first [11] Dr. Urist described the basic properties of BMP and its differing effect on various tissues and species. In the second [10] Nogami et al. describe a series of experiments documenting the ability of decalcified bone matrix to aggregate mesenchymal cells in minced muscle cell cultures and form calcified cartilage. In the third [15] Urist and Strates described the ultrastructure of a processed demineralized bone matrix constituting,

"...3% of the dry fat-free weight of the tissue occupy nearly a third of the matrix domain. These constituents include large molecules of bismuth nitrate-staining proteoglycans with attachments to collagen fibrils. The development of bone and bone marrow in implants of residues of matrix derived from

enzymatic cleavage, chemical extraction, or organic blocking procedures, suggests bone morphogenetic activity resides in an interfibrillar macromolecular protein complex."

One can get some sense of the laborious process requiring hundreds of experiments to characterize BMP. Marshall Urist had the scientific curiosity, intellectual creativity, and tenacity to not only isolate, identify, and characterize BMPs, but to stimulate a host of subsequent work. We are proud to pay tribute to such a pioneer.

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