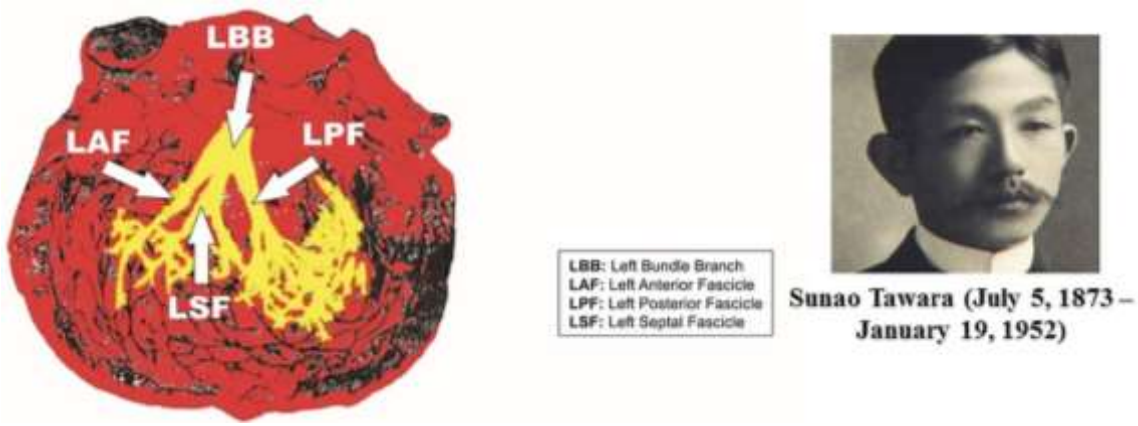
The Sunao-Tawara concept

At the beginning of the 20th Century, Dr. Sunao Tawara (1906) clearly showed that anatomically, the trunk of the LBB splits into three fascicles (Tawara 1906-1906).
Tawara's pioneering work on the conduction system *The Conduction System of the Mammalian Heart* (1906), still serves as an invaluable reference for basic and clinical research (Figure 1).
Sunao Tawara studied at the Imperial University in Tokyo, and graduated in 1901, and achieved a degree of Doctor of Medical Science, *Igaku Hakushi*, in 1908. Between 1903 and 1906, he was studying pathology and pathological anatomy with Karl Albert Ludwig Aschoff (1866-1942), in Marburg. There, he undertook his important works on the anatomy and pathology of the heart. When he returned to Japan in 1908, he was appointed as an extraordinary professor of pathology in Fukuoka, becoming "ordinarius" of this specialty.

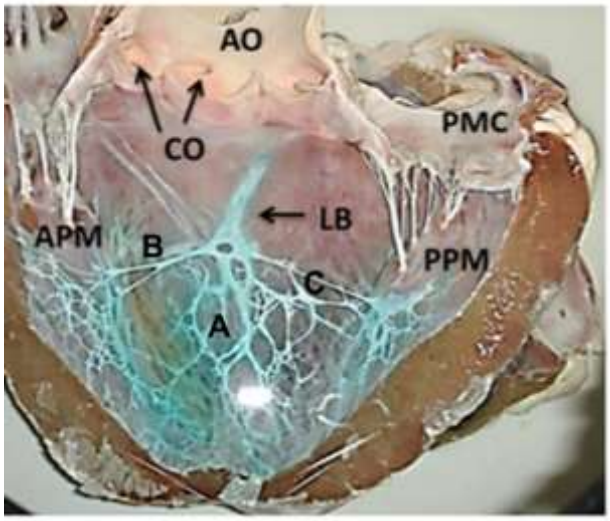
Figure 1. The trifascicular nature of the left His system following Tawara's concept: the "atrioventricular connecting system" - A Macroscopic Image of the Left Ventricle of the Human Heart



Tawara's representation of the open human heart showing the LBB with its characteristic three main divisions and Purkinje network
The trunk of the LBB of the His bundle splits into three fascicles: Left Anterior Fascicle (LAF), Left Septal Fascicle (LSF) and Left Posterior Fascicle (LPF).
Tawara wrote: "*The system is a closed muscle bundle that resembles a tree, having a beginning, or root, and branches…. The system connects with the ordinary ventricular musculature for the first time at the terminal ramifications*." (Keith 1906).

Knowledge of the conduction system of the heart was greatly advanced by Tawara's work carried out at the Aschoff's laboratory in Marburg at the beginning of this century. He studied pathology and pathological anatomy with Ludwig Aschoff. It was here he undertook his important works on pathology and anatomy of the heart. In his monograph, entitled "*Das Reizleitungssystem des Säugetierherzens*" that means "The Conduction System of the Mammalian Heart An Anatomic-Histologic Study of the Atrioventricular Node and the Purkinje Fibers", published in 1906, Sunao Tawara traced the atrioventricular (AV) bundle of His backward to find a compact node of fibers at the base of the atrial septum and forward where it connected with the bundles of cells discovered by Purkinje in 1839. The Purkinje network is not macroscopically visible in human hearts. Sunao Tawara found himself in trouble in the early 1900s, when studying the human heart network. He gained a much better understanding of the net after starting to work with

ungulates' hearts. The ungulate heart is proposed as an auxiliary didactic model for the study of the human conduction system (De Almeida 2014). This author shows the following trifascicular structure.



Left ventricular cavity with opened mitral valve and aorta, showing the characteristic position of left bundle. AO Aorta, APM anterior papillary muscle, CO coronary ostia, LB left bundle, PMC posterior cusp of mitral valve, PPM posterior papillary muscle, A middle fibers or left septal fascicle, B left anterior fascicle, C left posterior fascicle

Tawara concluded that this "AV connecting system" originated in the AV node, penetrated the septum as the His bundle, and then divided into left and right bundle branches (LBB and RBB) that terminated in the Purkinje fibers and served as the pathway for the atrioventricular conduction of excitation in the mammalian heart. From his own anatomic and histological findings of the conduction system, he assumed precisely that the conduction velocity of excitation in the system, except in the AV, would be fast and that contraction as the result of excitation would take place at the various sites of the ventricles almost simultaneously. According to Tawara, a long pathway to each contracting unit and a fast conduction velocity of excitation would be a prerequisite for the effective contraction of the ventricles. Tawara's findings and assumptions provided Einthoven with the theoretical basis for interpreting the ECG, resulting in a rapid dissemination of electrocardiography (Suma 2001).

Summary of Tawara's career: Sunao Tawara studied at the Imperial University in Tokyo, graduating there in 1901, and as Igaku Hakushi (PhD) in 1908. From 1903 to 1906 he lived in Marburg studying pathology and pathological anatomy with Karl Albert Ludwig Aschoff (1866-1942). It was here he undertook his important works on the anatomy and pathology of the heart. When he returned to Japan he was appointed extraordinary professor of pathology in Fukuoka, becoming *ordinarius* of this specialty in 1908.

References

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