

## Mathematics in the Life Sciences

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This lecture introduced activities of the Mathematical Biology Group, with a bird's eye view of mathematical models of brain (covariant, generalized coupling, covariant generalized coupling, mathematical definition of brain death), heart (standing wave), spinal column (static and dynamic), physical growth of children (statistical, ICP, KFA) and clinical examination (inverse problem, precedence and influence graphs used in the ordering of examination sequence). The spinal-column models generate 3-D profile of the human backbone using non-contact, non-invasive measurements obtained from moiré contours. Moiré fringe topography and rasterstereography are stereophotogrammetric techniques, which provide height and curvature maps of a surface, respectively. These techniques supplemented by edge-based moiré and edge-based raster have the potential to be applied to security technologies, gymnastic training, speech, posture and gait analyses of child, detect and quantify curvatures of spinal column (scoliosis, kyphosis and lordosis). The emphasis, then, shifted to the NGDS (National Growth and Developmental Standards for the Pakistani Children) Pilot Project as the speaker's main sphere of interaction with (Late) Syed Firdous (SF), who was associated with this project from its inception in 1998 to his death on June 21, 2008. He was involved in planning, implementation, community outreach, data collection, modeling and analysis involving measurements of heights, weights and mid-upper-circumferences (MUAC) of primary-school children (co-authored 10 papers with the Project Director). He had, himself, measured over 2000 children on the school premises (Fig. 1). This paper unveiled the next level of accuracy in height (Fig. 2; to 0.01 cm using a vernier scale pasted on the set square used in the NGDS-height-measurement system, combined with spirit-level and plumb-line checks for horizontal and vertical alignments, respectively), mass (Fig. 3; to 0.01 kg using a vernier scale pasted on the set square aligned with a beam scale, combined with spirit-level checks for floor and weighing scale) and MUAC (to 0.01 cm using a sliding vernier scale on a tailor's tape) measurement techniques<sup>#</sup>. In addition, the formula  $\mu = \mu_a + \mu_b - \mu_{a+b}$  could be used to compute net mass (mass with zero clothing) without asking the subject to disrobe completely ( $\mu$  is net mass,  $\mu_a$  mass with one set of clothing worn,  $\mu_b$  mass with the other set of clothing worn and  $\mu_{a+b}$  mass with both sets of clothing worn). Mathematics of body sizes, forms, proportions and structures may be termed as *Anthromathematics*. This lecture was dedicated to the memory of our loving colleague (SF), born on September 4, 1952 in Jacobabbad, Sindh (Pakistan), educated at University of Sindh. At the time of his death he was serving as Associate Professor and Head, Department of Mathematics, SM Government Science College, Karachi as well as Member, Board of Studies, Department of Mathematics, University of Karachi.

**Keywords:** Pakistan, Karachi, children, height, weight, measurement, stunting, wasting, adult-height prediction

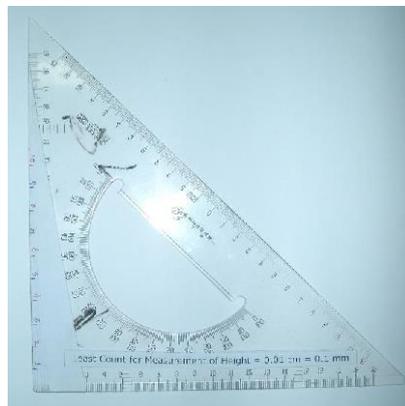
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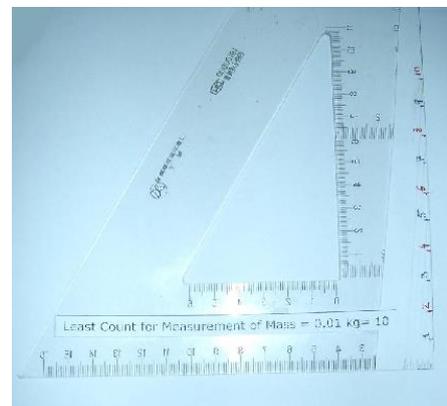
**Research Ethics:** Project initiated after *Institutional Review Process* and conducted in compliance with ethical and human-rights standards.



**Fig. 1.** An eight-year old boy being weighed by SF in the Growth-and-Imaging Lab



**Fig. 2.** Vernier scale mounted on set square to record height (least count of 0.01 cm using the NGDS system)



**Fig. 3.** Vernier scale mounted on set square to record mass (least count of 0.01 kg using the NGDS system)

**Web address of this document:** <http://www.ngds-ku.org/Presentations/Firdous.pdf>

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<sup>#</sup>The idea of using a vernier scale to go to the next level of accuracy was inspired by a physics-laboratory session of **Mr. Hussain Ahmed Bilgiri** conducted in 1972, when the author was studying in First Year Science at Government College, Hyderabad, Sindh, Pakistan.