it is important to read the instructions on the box and the package leaflet before using these tests. Generally, a drop of blood is placed on the reagent strip and left for 30 seconds to 1 minute, depending on the brand of strip. The blood is then wiped off, and after another fixed period of time (e.g. a further 1 minute), the colour change on the reagent field of the strip is read. For this, the resulting colour is compared with a colour scale printed on the box. This allows the user to estimate the glucose level to be within a certain range (e.g. between 2 mmol/litre and 5 mmol/litre), but it does not provide exact values.

Some strips come with a battery-powered electronic reading machine. After the blood has been wiped off, the strip is inserted into the reading machine, which provides a more accurate value. As the reagents deteriorate with exposure to ambient humidity, it is important that they are kept in a closed box, and that the box is closed immediately after a strip has been removed.

8.6 Assessing nutrition, growth and development

Measuring nutritional status
Calculating the child’s weight for length
This is the most relevant measurement in nutritional assessment.

Measuring length
At ≤ 2 years
Ideally two people are needed to take this measurement, and the child should be supine on a flat surface.
The first person should:
• assist in positioning the child face up on the measuring board, supporting the head and placing it against the headboard
• position the crown of the head against the headboard, compressing the hair
• check that the child lies straight along the centre line of the board and is not slanted, and does not change position (it is usual for this person to stand or kneel behind the headboard).

The second person should:
• support the trunk as the child is positioned on the board
• lie the child flat along the board
• place one hand on the shins above the ankles or on the knees and press down firmly, and with the other hand place the foot-piece firmly against the heels
• measure the length (to the nearest 0.1 cm) and record it immediately.

The measuring board should be checked for accuracy every month.

At ≥ 3 years
• This measurement should be taken without the child wearing shoes.
• The child should stand with their heels and back in contact with an upright wall.
• The head is held to look straight forward with the lower eye sockets in line with the ears. The nose must not be tilted upward.
• A weighted block at right angles to the wall is then lowered on to the head and a scale fixed to the wall is read.
• During measurement the child should be asked to stretch their neck to be as tall as possible, but their heels must not leave the ground. The measurer should help to stretch the neck by firm pressure upward under the mastoid processes.
• Measure the height immediately to within 0.1 cm.
Measuring weight

At ≤ 2 years
- Leave a cloth in the weighing pan to prevent chilling of the child.
- Adjust the scales to zero with the cloth in the pan.
- Place the naked child gently on the cloth in the weighing pan.
- Wait for the child to settle and the weight to stabilise.
- Measure the weight (to the nearest 10 grams) and record it immediately.

Standardisation of the scales should be performed weekly or whenever the scales are moved.

At ≥ 3 years
- The child should be weighed naked or, if pants are worn, 0.1 kg should be subtracted from the weight measured.
- The bladder should be emptied before weighing.

Determining the child’s percentage weight for length or SD weight for length

See Figure 8.6.1.
- Locate the row containing the child’s length in the central column of the table.
- Look to the left in that row for boys, and to the right for girls.
- Note where the child’s weight lies with respect to the weights recorded in this row.
- Select the weight closest to that of the child.
- Look up this column to read the weight for length of the child.

Note: Although the interpretation of a fixed percent-of-median value varies across age and height, and generally the two scales cannot be compared, the approximate percent-of-median values for –1 SD and –2 SD are 90% and 80% of the median, respectively (Bulletin of the World Health Organization, 1994, 72, 273–83).

Length is measured below 85 cm; height is measured at 85 cm or above. Recumbent length is on average 0.5 cm greater than standing height, although the difference is of no importance to the individual child. A correction may be made by deducting 0.5 cm from all lengths above 84.9 cm if the standing height cannot be measured.

Example 1. Boy of length 61 cm and weight 5.3 kg; this child is –2 SD weight for length (84% of the median: 5.3 divided by 6.3 x 100).

Example 2. Girl of length 67 cm and weight 4.3 kg; this child is less than –4 SD weight for length (less than 60% of the median: 57%).

Monitoring weight gain
Calculating weight gain

The example below is for weight gain over 3 days, but the same procedure can be applied to any interval.
- Subtract the child’s weight (in grams) that was measured 3 days earlier from their current weight.
- Divide by three to calculate the average daily weight gain (grams/day).
- Divide by the child’s average weight (in kg) to calculate the daily weight gain per unit body weight (grams/kg/day).

Monitoring charts: explanation of the charts on the following pages

Figure 8.6.2 shows a weight chart which has been used to monitor the weight gain of a severely malnourished child. The horizontal ‘x’ axis represents the number of days after admission, while the vertical ‘y’ axis represents the weight of the child in kilograms (kg).
Notice that the weight in kilograms is stepped in 0.5-kg increments. In this example, the range has been written in from 5.0 to 7.5 kg to provide a suitable range for this individual child’s expected growth.

For other children, fill in the starting weight at the appropriate level (e.g., 5 kg, 5.5 kg, 6 kg, etc., or 7 kg, 7.5 kg, 8 kg, etc.).

Choosing an appropriate starting weight like this is preferable to using a chart with weights marked from 0, because this more flexible chart gives a larger scale and thus shows the pattern of change much more clearly.

Figure 8.6.3 shows a blank intake and output chart for recording the food given to an individual patient, the amount consumed, and any losses through vomiting or diarrhoea.

Additional measurements for assessing nutritional status

Mid upper arm circumference (MUAC)

This is measured with non-stretchable tape placed around the arm midway between the elbow and the shoulder.

The tape should be gently tightened, but not so much that it compresses the underlying tissues.

This measurement includes fat and muscle.

Normal values of MUAC for a child aged 1–5 years are in the range 14.0–16.5 cm.

For a child aged 1–5 years, a MUAC of < 12.5 cm indicates that the child is definitely malnourished, and a MUAC in the range 12.5–13.5 cm indicates that they are probably malnourished.

Triceps skinfold thickness

Special skinfold callipers are used to measure the double layer of skin and subcutaneous fat overlying the triceps muscle when the skinfold is lifted.

Measuring growth and development

Individual measurements of weight and height/length can be plotted sequentially on charts to identify any failure of growth. See the charts below for height and weight for boys and girls. These charts also include data for infants born prematurely, as well as head circumference measurements.
FIGURE 8.6.7 Supine length and head circumference chart for boys from birth to 2 years. Based on World Health Organization data.

FIGURE 8.6.8 Weight chart for girls aged 2–18 years. Based on World Health Organization data.

FIGURE 8.6.9 Height chart for girls aged 2–18 years. Based on World Health Organization data.

FIGURE 8.6.10 Weight chart for boys aged 2–18 years. Based on World Health Organization data.

FIGURE 8.6.11 Height chart for boys aged 2–18 years. Based on World Health Organization data.

Measurement of head circumference
- Use a non-stretchable tape.
- Measure around the forehead above the eyebrows to the maximum occipital point.
- Measure twice for accuracy.

Assessment of pubertal state
Girls
The following should be recorded.

Breast development
- **Stage 1.** Pre-adolescent: elevation of papilla only.
- **Stage 2.** Breast bud stage: elevation of breast and papilla as a small mound, and enlargement of areola diameter.
- **Stage 3.** Further enlargement and elevation of breast and areola, with no separation of their contours.
- **Stage 4.** Projection of areola and papilla to form a secondary mound above the level of the breast.
Section 8.6

- **Stage 5.** Mature stage: projection of papilla only, due to recession of the areola to the general contour of the breast.

**Pubic hair**
- **Stage 1.** Pre-adolescent: the vellus over the pubes is not further developed than that over the abdominal wall (i.e. there is no pubic hair).
- **Stage 2.** Sparse growth of long, slightly pigmented downy hair, straight or slightly curled, chiefly along the labia.
- **Stage 3.** Hair is considerably darker, coarser and more curled, and spreads sparsely over the junction of the pubes.
- **Stage 4.** Hair is now adult in type, but the area covered is still considerably smaller than in the adult; there is no spread to the medial surface of the thighs.
- **Stage 5.** Hair is adult in quantity and type, with distribution of the horizontal (or classically ‘feminine’) pattern; there is spread to the medial surface of the thighs but not up the linea alba or elsewhere above the base of the inverse triangle (spread up the linea alba occurs late, and is rated as Stage 6).

Document whether axillary hair is present.

Document age at menarche.

**Boys**
The following should be recorded.

**Genital (penis) development**
- **Stage 1.** Pre-adolescent: the testes, scrotum and penis are of about the same size and proportion as in early childhood.
- **Stage 2.** Enlargement of the scrotum and testes. The skin of the scrotum reddens and changes in texture. There is little or no enlargement of the penis at this stage.
- **Stage 3.** Enlargement of the penis, which initially is mainly an increase in length. Further growth of the testes and scrotum.
- **Stage 4.** Further enlargement of the penis, with an increase in breadth and development of the glans. The testes and scrotum are larger, and the scrotal skin is darkened.
- **Stage 5.** Genitals are adult in size and shape.

**Pubic hair**
- **Stage 1.** Pre-adolescent: the vellus over the pubes is not further developed than that over the abdominal wall (i.e. there is no pubic hair).
- **Stage 2.** Sparse growth of long slightly pigmented downy hair, straight or slightly curled, chiefly at the base of the penis.
- **Stage 3.** Hair is considerably darker, coarser and more curled, and spreads sparsely over the junction of the pubes.
- **Stage 4.** Hair is now adult in type, but the area covered is still considerably smaller than in the adult; there is no spread to the medial surface of the thighs.
- **Stage 5.** Hair is adult in quantity and type, with spread to the medial surface of the thighs but not up the linea alba or elsewhere above the base of the inverse triangle (spread up the linea alba occurs late, and is rated as Stage 6).

Document whether axillary hair is present.

**Testicular volume**
The approximate volume at each genital stage is shown.
- **Stage 1:** 1.5–3 mL.
- **Stage 2:** 4–6 mL.
- **Stage 3:** 6–10 mL.
- **Stage 4:** 10–12 mL.
- **Stage 5:** 15–20 mL.