tion of the more important of these and their principles of operation will be found in Volume III of this book.

E. BLOOD COUNTS AS INDEX OF INJURY

In spite of all due caution in manipulations and proper measurements to insure that the tolerance dose is not exceeded, it is conceivable that some individuals may be more than ordinarily sensitive to radiation, or may accidentally receive excessive exposures not detected by metering badges supposedly worn by all personnel in radiation areas. The best check on such possibilities known at present is the use of regular blood counts. Although such observations are not satisfactory for revealing moderate overexposures, it is well established that strong irradiation by penetrating radiation causes characteristic changes in the blood picture. The real difficulty is that these changes frequently become definitely recognizable only after the damage has been done. Furthermore, the results of the counts, which always should be made by the same technician for each person under observation, and under similar conditions, should be interpreted by an experienced hematologist. These counts should include: hemoglobin test, red, white, and differential counts, including the percentages of polymorphonuclear cells, small and large lymphocytes (separately), eosinophiles and basophiles. Blood platelet, sedimentation, and coagulation tests also are of value.

A guide in determining departures from a normal blood count is provided by Table 3 as given by Goodfellow,[4] who has investigated the effects on the blood count of exposures to gamma rays. He finds that the only sign of overexposure common to all workers is a leucopenia, due to a reduction of circulating neutrophiles. There is evidence that different individuals vary in susceptibility to the effects of irradiation. Those who are more sensitive exhibit an absolute lymphocytosis with an absolute leucopenia as the first sign of overexposure. Others, less sensitive, under the same conditions show a lymphocythemia with a monocytosis. Eosinophilia is frequently seen as a result of overexposure, and abnormal or embryonic leucocytes have been observed. Goodfellow states that vacations of less than four weeks do not appear to be of value in restoring leucocyte counts to normal.

F. RADIOISOTOPES

In the last ten years the use of artificially produced radioisotopes of many common elements has given rise to new industrial problems of protection, which may be expected to grow in magnitude and complexity. Although the principles of health protection remain the same as in the days when radium and its decay products were about the only sources of radioactivity, they must now be applied to a greater variety of situations. There are available now, also, sources of many times the intensity of former preparations of radium. At the same time many types

[4] D. R. Goodfellow, *Brit. J. Radiol.*, **8**, 669, 752 (1936).

TABLE 3

Typical Blood Counts as Reported by Various Authorities

Type of cell	Mottram	Schilling	Dyke	Shaw	Emerson	Simpson	Simpson: Widest variations observed	Taylor, *Practice of Medicine:* Accepted normal limits (in morning)
Total W.B.C.s								
Max.	—	8,000	8,500	9,650	8,000	11,200	18,100	9,000
Min.	—	6,000	5,500	3,200	6,000	5,100	2,800	4,000
Mean	—	—	—	5,987	—	—	—	—
Neutrophiles								
Max.	12,000	—	75%	69.8%	70%	8,920	13,100	5,000
Min.	3,000	—	60%	37.0%	63%	2,920	1,600	2,500
Mean	—	67%	—	53.2%	—	—	—	—
Lymphocytes								
Max.	6,000	—	40%	51.2%	30%	2,440	4,040	3,000
Min.	1,500	—	25%	22.6%	20%	1,010	820	1,500
Mean	—	23%	—	36.8%	—	—	—	—
Monocytes								
Max.	—	—	7%	10.0%	10%	—	—	600
Min.	—	—	2%	3.0%	—	—	—	20
Mean	—	6%	—	6.7%	—	—	—	—
Eosinophiles								
Max.	—	—	2%	6.4%	2%	—	—	400
Min.	—	—	0%	0.0%	—	—	—	20
Mean	—	3%	—	2.5%	—	—	—	—
Basophiles								
Max.	—	—	1%	2.0%	0.5%	—	—	10
Min.	—	—	0%	0.0%	—	—	—	0
Mean	—	1%	—	0.7%	—	—	—	—

of work involving radioactivity, for example, investigations with radioactive tracers, conveniently use relatively weak sources.

In a general survey of precautions required it is convenient to divide the various operations into several ranges of intensity. At present the commonly used unit for measurement of the quantity of radioactivity is the curie, defined as that amount of any radioisotope which is undergoing 3.7×10^{10} disintegrations per second. This automatically defines a different number of atoms for each radionuclide as a unit quantity, through the relation $dN/dt = -\lambda N$, where N is the number of atoms present at the moment of measurement, dN/dt is the rate of disintegration, and λ is the disintegration constant. N for one curie of a nuclide is then defined by $3.7 \times 10^{10} = -\lambda N$; and, since λ is different for each nuclide, N will also be different. However, for a given nuclide the radiation emitted is