Migratory Patterns of Different Indium-111 Labeled Leukocyte Populations (Chiefly Lymphocytes) from Control and Thymectomized Rats

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The blood clearance and 24-hr organ distribution of five lymphocyte-rich suspensions harvested from different source organs were compared in the Wistar rat, after labeling with [^{111}In]tropolone and intravenous injection. Peripheral blood lymphocytes (chiefly T cells) had the highest levels in the blood and lymph nodes, a relatively higher level in intestine and a lower level in the spleen than other suspensions. Thymocytes cleared promptly from the blood, accumulated markedly in the liver, moderately in the spleen, but very poorly in other organs, including the thymus. Splenic cells (rich in B cells) sequestered predominantly in the spleen and liver. Splenic cells nonadherent to nylon wool (T-cell enriched) had a relatively high uptake in lymph nodes and marrow. Splenic cells from thymectomized rats (NK cell enriched) localized predominantly in the liver and spleen, and poorly in lymph nodes. We conclude that the source organ for harvesting rat lymphocytes is an important determinant in their localization, as well as other factors such as the techniques of isolation, the toxicity and stability of the radioactive label and the cell radiation dose from internalized radioactivity.

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The question whether or not different lymphocyte subsets have characteristic circulation pathways has not been uniformly answered (*1–5*). Technical variations in cell harvesting and labeling have confounded the migration picture. It has been claimed, for instance, that there are differences in results between indium-111 (^{111}In) and chromium-51 (^{51}Cr) on one hand, and ^{125}I iododeoxyuridine ([^{125}I]Udr) on the other (*6*). Iodine-125 Udr is incorporated in cells synthesizing DNA (*7,8*), but is regarded as toxic (*8,9*). Anionic, hexavalent disodium [^{51}Cr]chromate labels erythrocytes (*10–11*), leukocytes or cultured cells (*12*) but it tends to elute from the cells in addition to a low labeling efficiency and some random cell destruction during the first day following administration (*13,14*).

Indium-111 oxine complex (*15*) offers the advantage of easy penetration through lipid cell membranes for leukocyte labeling, but the cells have to be suspended in plasma-free media to avoid loss of the ^{111}In label to plasma transferrin (*15*). Indium-111 tropolonate efficiently labels leukocytes suspended in autologous (homologous) plasma or in isotonic media with considerable reduction of handling steps and is the label of choice in our laboratory (*16*). However, these ^{111}In lipophilic chelates bind chiefly to the nucleus (*17*), and lymphocytes are more susceptible to radiation damage than granulocytes, platelets or erythrocytes. A dose of 150 μCi ^{111}In/10^8 lymphocytes alters in vivo migration (*18*); 20 μCi may impair recirculation while 5 μCi cause no detectable damage, judging by lymph node uptake 24-hr postinjection or lymphocytic recirculation (*18*). For gamma camera imaging, 1 mCi of ^{111}In/10^8 cells will expose each lymphocyte to 1,000–1,700 rad/day (*19*), more than sufficient to elicit radiation damage. Based on these published data, our dose was limited to <10 μCi/10^8 cells.

The experiments of the present communication were

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undertaken in an attempt to clarify some aspects of the homing patterns of lymphocytes obtained from different source organs. Special emphasis has been placed on populations enriched with large granular lymphocytes (LGLs) or natural killer cells (NKs) that seem to be part of the first line of defense of the organism since they exert their cytolytic prowess *a priori* against some foreign targets, without previous exposure to the latter (*20–22*).

MATERIALS AND METHODS

Animals

Wistar rats, originally purchased commercially* were inbred for successive generations in the animal facilities of the Health Science Center at Syracuse. The animals were fed purina chow and water ad libitum and were maintained in a 12-hr light, 12-hr darkness cycle. Normal animals of both sexes, ages between 10 and 26 wk served as donors. For NK enriched suspensions, the donors were "multithymectomized" (mthx) animals, i.e., *neonatally thymectomized litters that are the first progeny of neonatally thymectomized mothers.* Only second (2-Thx), third (3-Thx), and fourth (4-Thx) thymectomized generation males and females were used, ages ranging between 5 and 10 wk. It has been our experience that the first generation (1-Thx) shows only a moderate, relative increase in NK cells ascribable to the fact that these lymphocytes are T independent and do not undergo reduction in numbers, while T dependent cells decrease drastically. The ensuing lymphopenia does not affect LGLs, thus eliciting a relative increase of the latter, that peaks by the 3-Thx and 4-Thx litters. Because of limited supply, however, we also included 2-Thx animals.

Recipients of the cell suspensions were control Wistar female rats, 11–28 wk of age (Table 1). Within the biologic limits of variability these five groups of recipients (20 animals in total) can be considered homogeneous.

Cell Suspensions

Leukocyte suspensions were prepared under sterile conditions as follows:

Experimental Group I: Peripheral Blood Leukocytes (PBL)

Blood obtained by intracardiac puncture under ether anesthesia was mixed with citric acid-sodium citrate-dextrose (ACD, USP formula A) as anticoagulant, in the proportions of 1–1.5 parts of anticoagulant to 8.5–9 parts of blood. An adult rat yielded 5–8 ml of blood. Twenty milliters of the mixture were transferred to a Sarsted Monovette Syringe† mixed with 6 ml of 1% methylcellulose‡ (*23*) and spun at 20 g for 20 minutes at room temperature. The leukocyte-platelet rich suspension was centrifuged at 450 g for 5 minutes to pellet the leukocytes while leaving the platelets in suspension. The leukocytes were subsequently resuspended in 0.5 ml of plasma and labeled.

Experimental Group II: Total Thymocytes

Thymuses from one or two donors were forced through 60″ gauge steel wire mesh in RPMI 1640 medium§ supplemented with 10% heat inactivated fetal calf serum.¶ The tubes were left for 45–60 min at room temperature to sediment gross clumps of tissue. Subsequently, the supernatant was collected and the cells were counted and resuspended at a concentration of 20–50 × 10^6/ml. To further purify the suspension from erythrocytes, clumps and debris, 1–2 ml. of the suspension were layered at the top of 1–1.5 ml of Percoll gradient 7** (*24*) and spun for 30 min at room temperature at 550 g. The cells at the interface were collected, washed three times with 9:1 RPMI 1640:FCS, resuspended in 0.5 ml of the same medium and labeled.

Experimental Group III: Total Splenic Cells

The experimental protocol was the same as for group II.

Experimental Group IV: Splenic, Nylon Wool Nonadherent Cells

(NWNA, T cell enriched suspension) (*24,25*).

One or more spleens were forced through 60″ gauge wire mesh and collected in 9:1 RPMI 1640:FCS. The tubes were

TABLE 1
Data on Experimental Groups of Wistar Rats

(A) Female recipients

Exp. group	No. animals	Age (days) Mean	Age (days) Range	Weight (g) Mean	Weight (g) Range	Calculated lymph mass (g) Mean	Calculated lymph mass (g) Range
I	4	158	93–196	256	206–302	0.664	0.592–0.731
II	4	120	79–166	255	209–338	0.673	0.576–0.862
III	4	159	109–233	254	219–311	0.658	0.618–0.730
IV	4	141	102–196	222	205–248	0.594	0.510–0.660
V	4	157	147–163	247	235–256	0.636	0.598–0.655

(B) Cell labeling and recovery

Exp. group	Millions of cells injected Mean	Millions of cells injected Range	Labeling efficiency % Mean	Labeling efficiency % Range	μCi injected Mean	μCi injected Range	Total % recovery in organs (24 hr) Mean	Total % recovery in organs (24 hr) Range
I	185	146–248	44	22–95	3.3	1.9–6.7	97	71–100
II	119	74–166	46	12–81	3.5	0.9–7.9	80	73–87
III	93	84–103	49	11–87	3.9	1.0–8.8	82	71–91
IV	120	75–200	28	14–95	3.1	1.8–5.6	96	69–100
V	104	80–154	80	65–86	7.2	7.1–7.4	87	82–100

left at room temperature for 45–60 min to sediment gross clumps of tissue. Subsequently, the supernatant was pipetted and the cells were adjusted to a concentration of 20–50 × 10^6/ml in the same medium. Ten milliters of this suspension were gently transferred to the top of 30 ml syringes packed with 4 g of nylon wool[††] previously soaked with warm RPMI:FCS. After loading the columns, an additional 10 ml of medium were slowly added at the top, the columns were sealed at both ends and incubated for ~50 min at 37°C. Then, the columns were washed with 50 ml of warm RPMI:FCS. The washes were spun (10 min at 400–450 g) and the NWNA fraction was collected and adjusted to a concentration of 20–50 × 10^6 cells/ml. The cells were further purified by centrifugation through Percoll 7 as described above, washed three times, resuspended in 0.5 ml of RPMI:FCS and labeled.

Experimental Group V: Splenic Cells, NK Enriched

2-Thx, 3-Thx and 4-Thx spleens were prepared as for the nylon wool non-adherent fraction. Since it has been repeatedly shown that NK cells congregate in the first three Percoll layers (*24,26*), the cells were centrifuged against Percoll gradient 4 (48.33% corrected Percoll, SG > 1.065 g/ml) then harvesting the combined fractions 1–3. After three washes with RPMI:FCS the cells were suspended in 0.5 ml of the same medium and labeled.

Cytologic Analysis

Cell counts of the injected suspensions were obtained with Coulter counters models Z_F or ZBI. Additional aliquots of the cell suspensions were adjusted to a concentration of about 3 × 10^6 cells per ml and two drops were spun for 5 min at 500 rpm in a cytocentrifuge[‡‡]. The cell buttons were fixed in methanol and stained by the Wright-Giemsa mixture at pH 6.4. The cells were examined and classified under an oil immersion lens to obtain the relative frequency of each cell type. Over 5,000 cells were scored in each group.

Indium-111 Labeling and Injection of Cells (Table 2)

Indium-111 purchased as carrier-free indium chloride [§§] at a concentration of 2 mCi/ml, was diluted 10 times. Fifty microliters (~10 μCi) were mixed with 50 μl of tropolone [¶¶] (1 mg/ml) in 0.2*M* HEPES buffer, added to the cell suspension, mixed gently and incubated at room temperature for 15 min. After incubation, 5 ml of RPMI:FCS were added and the suspension was spun at 450 g for 5 min and resuspended in 0.5 ml. The efficiency of the label was evaluated with a dose calibrator [***].

Recipient rats were anesthesized by intraperitoneal injection of chloral hydrate (0.01 ml of a 3% aqueous solution per gram of body weight) and 0.7–2.5 × 10^8 cells were injected through a tail vein in 0.5 ml RPMI:FCS.

Biodistribution

Blood samples (1 ml) were drawn at 1 and 4 hr postinjection for radioassay of whole blood and plasma.

Twenty-four hours postinjection (p.i.) the animals were killed under chloral hydrate anesthesia, dissected and the organs weighed and assayed for radioactivity. All experiments were repeated four times. To calculate the percent administered dose per organ, the following assumptions were made: blood volume, 6% of body weight (*27*); plasma volume, 6% of body weight times the plasmacrit; bone marrow, % dose to one femur÷0.095 (*28*); bone, 6% of body weight (*29*); and muscle, 45.5% of body weight (*29*). Other organs (except lymph nodes) were weighed and counted in toto.

Four to six superficial cervical lymph nodes were dissected, weighed and measured for radioactivity. The lymphatic mass (intestines, spleen and thymus excepted) was calculated according to Andreasen (*30*) (Table 1a). From this data, the *lymphoid mass tissue as a percent of body weight* was obtained for different ages, body weight and sexes (data will be provided on request).

The data on distribution of radioactivity 24 hr postinjection were expressed in two ways: as the percentage of the injected dose per whole organ or as relative concentration per organ (*31*).

$$\frac{\text{net CPM per organ}}{\text{net CPM injected}} \times \frac{\text{body weight}}{\text{organ weight}}$$

= % per g of organ × 1% body weight.

Statistical Treatment

The range of variability is expressed as 80% confidence limits above and below the mean value, resulting in a confidence interval with the mean value in the center. A confidence interval is obtained by multiplying the standard error (i.e., the standard deviation divided by the square root of the sample number) by Student's t value for a given percentile distribution and the number of degrees of freedom (DF). In our particular case, t.8 value for 3 DF = 1.638. Consequently,

$$80\%\ \text{confidence range} = \text{Mean} \pm \frac{SD}{\sqrt{4}} \times 1.638.$$

where SD = standard deviation and 4 = sample number.

RESULTS

Cell labeling data are listed in Table 1B. From the microscopic analysis of the five different cell suspensions injected in vivo, the relative frequency of the leukocyte subpopulations is shown in Table 2. In all preparations, lymphocytes represented more than 80% of the total. The NK-enriched splenic cells had a relative higher fraction of large granular lymphocytes, a small increase of large nongranular lymphocytes and fewer small lymphocytes than the other groups. The T-cell enriched splenic cells (Group IV) had a somewhat higher proportion of small lymphocytes than the splenic cells of Group III. The fraction of granulocytes was negligible except for the PBL (Group I).

The 24-hr biodistribution of radioactivity expressed as % administered dose/organ is shown in Table 3. Values for kidney, stomach, gastrointestinal contents, heart, muscle, and brain are not included because, together, they represent <5% of the injected dose. The total recovery figures are listed in Table 1B. Approximately 20% of the labeled cells are recovered in the spleen in Groups II–V. Group I has a lower value, despite the highest blood values persisting at 24 hr, and

TABLE 2
Relative Frequency (%) of Cells Injected

Group	Source	GRAN*	SML†	LGL‡	LL§	MONO¶	BL**	Other††	All lymph
I	Blood	13.6	61.9	3.31	17.9	2.45	0	.91	83.1
II	Thymus	.29	75.7	.42	16.4	.97	5.10	1.05	92.5
III	Spleen	2.58	63.8	2.02	18.4	5.77	5.66	1.78	84.2
IV	Spleen (T enriched)	1.65	71.4	3.38	20.2	.69	.93	1.80	95.0
V	Spleen (NK enriched)	1.96	34.1	24.2	25.4	6.98	4.57	2.85	83.7

*GRAN: Granulocytes.
† SML: Small and medium lymphocytes.
‡ LGL: Large granular lymphocytes.
§ LL: Large (nongranular) lymphocytes.
¶ MONO: Monocytes, reticular cells, macrophages.
** BL: Blasts.
†† OTHER: Erythropoietic and thrombopoietic series and cells otherwise "unclassifiable".

the rich vascularity of the spleen. Cells of Groups I and IV have high uptake in lymph nodes, those of Group III have intermediate values, and <6% of thymocytes or NK-enriched cells are retrieved there. Thymocytes and NK-enriched cells accumulate in the liver.

Less than 1% of the thymocytes are found in the lung or in the thymus. T-enriched splenic cells have a relatively high uptake in the marrow, and the bone uptake probably mirrors the marrow content. The levels in the intestine are highest for peripheral blood lymphocytes, but surprisingly low for all groups (especially II and V) despite its richness in lymphoid tissue.

The differences in blood levels during the first 24 hr between the first four groups are shown in Figure 1. The plasma activity was <2% at 4 hr and <1% at 24 hr. The levels for peripheral blood lymphocytes are much higher than for any of the other groups, but this may be partly a result of some labeled erythrocytes in the suspensions. Nonetheless, these high levels resemble those obtained in humans with ^{111}In-labeled peripheral blood lymphocytes (*32*). Thymocytes rapidly and almost totally disappear from the circulating blood.

The relative concentrations of radioactivity are depicted in Table 4. In the spleen, the differences between cell populations are not as apparent as in Table 3. The lymph node concentrations are high for peripheral blood and T-enriched splenic cells, intermediate for Group III splenic cells and very low for thymocytes and NK-enriched cells. On the contrary, the thymocytes and NK-enriched cells are hepatotrophic, whereas the peripheral blood cell hepatic activity is remarkably low. The pulmonary and thymic concentrations of thymocytes are low. NK-enriched cells also appear to avoid the thymus. T-enriched splenic cells have a relatively high uptake in the marrow, also reflected in the bone uptake. Peripheral blood lymphocytes have the highest concentration in the blood, and thymocytes, the lowest level.

DISCUSSION

The five leukocyte populations examined have different cytologic, functional, and homing characteristics. Peripheral leukocytes in the rat comprise a heterogeneous population containing 83% lymphocytes, chiefly T-cells (*33–36*). Thymus cells (Group II) comprise >90% immature lymphocytes and 5% blast cells. In the

TABLE 3
24-hr Biodistribution of Radioactivity (% Administered Dose/Organ) Mean and (80% Confidence Limits)

Exp group	Spleen	Lymph nodes	Liver	Lung	Thymus	Bone marrow	Bone	Blood	Intestines
I	11.7	20.7	15.7	3.4	0.9	3.7	5.6	26.6	3.1
	(13.1–10.3)	(28.7–12.8)	(24.4–7.0)	(4.4–2.4)	(1.5–0.3)	(4.3–3.2)	(6.6–4.6)	(36.6–16.5)	(4.2–2.0)
II	17.1	2.8	42.5	0.7	0.1	3.8	6.0	1.2	0.8
	(20.7–13.5)	(4.0–1.6)	(45.2–39.7)	(0.8–0.6)	(0.2–0)	(5.0–2.6)	(6.8–5.2)	(1.4–1.0)	(0.9–0.7)
III	18.0	11.6	25.3	2.5	0.9	5.4	8.9	3.8	2.0
	(22.3–13.7)	(16.2–7.0)	(29.8–20.7)	(3.3–1.7)	(1.5–0.3)	(7.3–3.5)	(11.3–6.4)	(4.4–3.3)	(2.4–1.6)
IV	18.2	18.2	15.2	1.9	0.5	15.3	21.8	4.7	2.4
	(25.4–10.9)	(28.3–8.1)	(16.6–13.6)	(2.7–1.1)	(0.6–0.3)	(23.2–7.3)	(31.3–12.3)	(6.6–2.8)	(3.4–1.4)
V	19.4	5.6	31.5	2.5	0.2	6.2	9.0	9.6	1.2
	(23.3–15.6)	(6.1–5.1)	(35.5–27.5)	(3.5–1.5)	(0.3–0.1)	(8.4–4.0)	(11.7–6.3)	(16.2–3.0)	(1.5–0.9)

spleen, ~50% of lymphocytes are B cells (*33–36*); hence, the cell population of Group III should be considered B-enriched, in comparison with PBL. In splenic cells passed through nylon wool, T and null cells are eluted from adherent macrophages, B cells, blasts, and blastoid cells (*25*).

Therefore, Group IV populations should contain predominantly T cells because null cells comprise <10% of the eluate (*25,37*). The splenic cells from multithymectomized rats separated on Percoll gradients contained about 50% large lymphocytes equally distributed between granular and nongranular cells. The relative frequency of LGL-NK cells was increased by a factor of ~7 compared with the populations in Groups I–IV, providing some hints of different homing patterns. Further purification of these cells was not carried out, because the loss in cell number would preclude successful labeling.

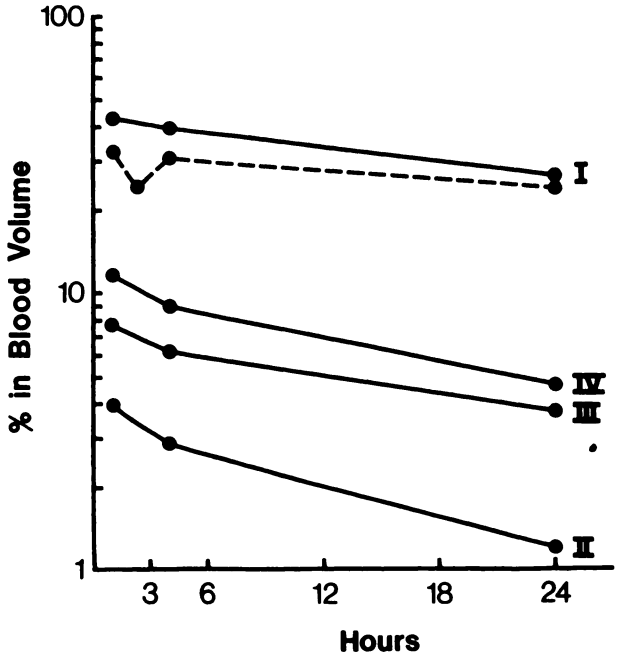

FIGURE 1
Blood clearance of four ^{111}In-labeled leukocyte populations in the rat (corrected for radioactive decay). Dashed line represents clearance of peripheral blood lymphocytes in the human (data from Wagstaff J, et al. (*32*) for comparison).

Our relatively high levels of PBL (predominantly T cells) in the blood are similar to those in man with [^{111}In]oxine PBL (*32*). This suggests that the relatively low blood levels in rats for lymphocytes obtained from other source organs is not just a species difference. The high uptake of PBL in peripheral lymph nodes is compatible with the finding that the majority of lymph node cells are T dependent (*33,35,36*). Likewise, the uptake of cells of Group IV (T-enriched splenic cells) in lymph nodes is higher than in the remaining groups (II, III, and V). These cells unexpectedly concentrate in the marrow, confirming a recent claim that most lymphocytes in human bone marrow bear T cell markers (*38*).

Thymocytes have a low homing pattern for lymph nodes, lung, thymus, and marrow, perhaps attributable to their immature nature, but are extracted almost completely from the blood by the liver and, to a lesser extent, the spleen. The splenic cells (Group III) containing both B and T cells home chiefly to the liver and spleen and less to lymph nodes.

Early reports (*1–4*) suggest that small lymphocytes have no preferential homing tendencies; later work suggests the opposite conclusion. Experiments of Stevens et al., for example (*5*), indicate that B cells preferentially migrate to the spleen and Peyer's patches, and T cells to peripheral lymph nodes. They believe that organ-specific homing is controlled by interaction between lymphocytes and endothelial cells of postcapillary high endothelial venules (HEV) through specific surface receptors. Smith and Ford (*39*) call into question the reliability of some previous migration and kinetic studies of lymphocytes. When lymphocytes are collected from spleen or lymph nodes or collected overnight from the thoracic duct (TDL), their ability to cross HEV is drastically impaired compared with TDLs reisolated from blood or lymph. Using the latter cell

TABLE 4
Relative Concentrations of Radioactivity 24-hr Postinjection % Injected Dose/g Organ × 0.01 Body Weight—Mean and (80% Confidence Limits)

Exp group	Spleen	Lymph nodes	Liver	Lung	Thymus	Bone marrow	Bone	Blood	Intestines
I	68.5	77.8	3.2	6.5	7.3	1.3	0.9	4.4	1.6
	(82.3–54.6)	(102.7–52.9)	(3.8–2.6)	(8.6–4.3)	(10.6–4.1)	(1.4–1.1)	(1.1–0.8)	(6.1–2.7)	(2.1–1.2)
II	72.3	10.7	13.4	1.5	0.7	1.3	1.0	0.2	0.4
	(92.6–52.1)	(15.4–6.0)	(13.8–13.0)	(1.8–1.2)	(1.2–0.3)	(1.5–1.2)	(1.1–0.9)	(0.2–0.2)	(0.4–0.3)
III	94.3	45.2	7.9	4.4	7.5	2.0	1.5	0.6	0.9
	(109.7–78.9)	(63.6–26.7)	(9.2–6.6)	(5.7–3.0)	(14.8–0.3)	(2.6–1.5)	(1.9–1.1)	(0.7–0.5)	(1.0–0.8)
IV	91.9	66.1	6.1	3.9	3.3	4.6	3.6	0.8	0.9
	(117.0–66.7)	(100.0–32.6)	(7.5–4.8)	(5.6–2.3)	(4.5–2.1)	(6.8–2.5)	(5.2–2.1)	(1.1–0.5)	(1.3–0.5)
V	69.7	22.0	10.4	5.0	1.7	1.9	1.5	1.6	0.5
	(77.0–62.5)	(23.9–20.1)	(11.4–9.5)	(6.7–3.2)	(2.2–1.3)	(2.6–1.3)	(2.0–1.0)	(2.7–0.5)	(0.7–0.4)

sources, the circulation time from blood to lymph is shortened from hours to 5–10 min. They recommend minimal handling and a short in vitro time for the cells. Consequently, their measured concentrations of T lymphocytes (reisolated TDL cells) in lymph nodes are much higher than in other reports (Table 5).

Our biodistribution results with predominantly T cell suspensions (PBL and spleen NWNA cells) are compared with other reported studies in rats from 18–24 hr in Table 5. Considerable variation, particularly in splenic and hepatic activity is apparent from one study to another. Cells isolated with H_3-uridine have low organ levels. In most reports, ~20% to 30% of predominantly T-cell suspensions localize in peripheral lymph nodes. Localization in the intestine, lungs, and marrow generally is low at 24 hr, and extremely low in the thymus.

Our biodistribution values for LGL-enriched cells are similar to those of Reynolds et al. (*40*). These cells have a predilection for liver and spleen and a low concentration in lymph nodes and intestine. This homing pattern is suggested also (*41*) by a higher concentration of cytotoxic LGL in the liver microcirculation than in the portal vein, and a high concentration in the spleen as well. Rolstad et al. (*42*) and Reynolds et al. (*40*) report a relatively high and persistent concentration of LGL in the lungs; however, this could be due, in part, to cell trauma from the lengthy in vitro cell separation methods used. A failure to recover these labeled LGL cells in the thoracic duct lymph indicates that these cells do not recirculate (*42*).

The current study confirms previous conclusions (*39,43*) that the source organ and technique of harvesting are important determinants in lymphocyte localization. Other important parameters influencing lymphocyte viability and migration include (a) the nature of the radioactive label and its toxicity in relation to the number of cells labeled, and (b) the cell radiation dose from the internalized radioactivity. Prior irradiation of cells (100–400 rad) plus a labeling dose ≥40 μCi ^{111}In/10^8 cells impairs lymphocyte migration whereas host sensitization amplifies localization (*43*). Indium-111 may contain nonradioactive contaminants that compete with the radionuclide in binding oxine or other lipophilic chelates and are toxic to lymphocytes (*44*). This adverse effect is avoided when these contaminants (except calcium) are no more than 0.5 ppm (*44*).

TABLE 5B
Organ Distribution of Labeled Lymphocytes in Rats at 18–24 hr Postinjection (% Dose/Organ)

	LGL enriched		
Label	^{111}In	^{3}H-U	^{111}In
Author(s)	Reynolds	Rolstad	Garcia
Reference	40	42	This communication
Cell source	Blood	Blood	Spleen
Lymph nodes		>0.2	5.6
Spleen	20.9	6.0	19.4
Liver	31.9	11.5	31.5
Gut		1.9	1.2
Lung	6.5	10.0	2.5
Marrow			6.2
Blood	4.0	1.9	9.6
Thymus		0.1	0.2

NOTES

* Microbiological Associates Laboratory Animals, Walkersville, MD 21793.

† Sarsted Inc., P.O. Box 4090, Princeton, NJ.

‡ (Methocel A25) Dow Chemical Co., Midland, MI.

§ Wittaker Bioproducts, Walkersville, MD.

¶ Gibco Labs, Grand Island, NY.

** Pharmacia Fine Chemicals AB, Uppsala, Sweden.

†† Cellular Products, Buffalo, NY.

‡‡ (Cytospin) Shannon Southern Products, Ltd., Runcorn, Cheshire, England.

§§ (Product 6071) Medi-Physics, Emeryville, CA.

¶¶ (Cat. T-8, 970-2) Aldrich Chemical Co., Milwaukee, WI.

*** (Model CRC-30) Capintec Inc., Ramsey, NJ.

TABLE 5A
Organ Distribution of Labeled Lymphocytes in Rats at 18–24 hr Postinjection (% Dose/Organ)

	Chiefly T Cells									
Label	^{51}Cr	^{51}Cr	^{111}In	^{51}Cr	^{111}In	^{51}Cr	^{111}In	^{3}H-U	^{111}In	^{111}In
Author(s)	Rannie	Rannie	Rannie	Smith	Sparshott	Smith	Reynolds	Rolstad	Garcia	Garcia
Reference	45	46	46	4*	44*	39	40	42	This communication	This communication
Cell source	TDL	TDL	TDL	TDL	TDL	TDL	Blood	Blood	Blood	Spleen NWNA
Lymph node	30.7	26.5	30.8	25.6	20.3	>50		>2.1	20.7	18.2
Spleen	18.0	22.0	31.5	18.7	18.4	16	22.8	5.5	11.7	18.2
Liver	11.4	9.0	9.6	9.9	32.5	5	25.2	7.9	15.7	15.2
Gut	2.4	2.9	3.6	4.4		2–6		2.3	3.1	2.4
Lung	2.8	1.8	1.6	2.1	2.2	2	1.0	1.1	3.4	1.9
Marrow	5.2	2.3	2.1						3.7	15.3
Blood	3.6	1.3	2.3		3.2	3–4	2.2	0.2	26.6	4.7
Thymus	0.07							0.3	0.9	0.5

* Corrected to represent % dose/organ.

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