

# A profile of senior research associates: Characteristics and trend analysis

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*The Council of Scientific and Industrial Research (CSIR) has been operating the 'Scientists' Pool Scheme' since 1958. Under this scheme, Senior Research Associateships are offered to highly qualified and unemployed Indian S&T personnel, trained in India and/or abroad. Over the years more than 10,000 persons have benefitted by availing the Associateship. The present study based on the data compiled from the records of 899 SRAs who left during 1991 to 1995 after serving for full or partial tenure, has revealed many interesting characteristics and noteworthy trends. About one-third of the SRAs were trained from abroad, more than half of them belonged to medical stream and one-third belonged to natural sciences groups. More than half of the SRAs belonging to natural sciences sought placement in University Systems and the remaining in CSIR and other R&D organizations. The percentage of SRAs from natural sciences group availing a full tenure of 36 months was much higher than those belonging to medical and engineering groups. The data on placement in relation to ultimate absorption in regular employment showed that a large number of the SRAs placed in universities and medical colleges were absorbed in the same sectors against regular positions. Thus the scheme has been serving useful purpose in developing Human Resource in S&T sector and providing a band of well-trained R&D manpower to various Indian institutions.*

THE Council of Scientific & Industrial Research (CSIR) has been awarding Senior Research Associateships (SRAs) for a maximum of three years' tenure to foreign as well as Indian qualified S&T personnel under the Scientists' Pool scheme. The scheme is about four decades old and has undergone many revisions based on the recommendations of the review committees appointed from time to time to make it more effective with the changing Indian scenario. The purpose of the scheme is to nurture and develop human resource for carrying out research and development activities in India. The scheme has many unique features. The applicants from abroad are considered in absentia and if selected, the SRAship is offered to them. They have the flexibility to join the SRAship within one year period from the date of issue of the offer, if acceptance is received within three months after the offer. The scheme has been made very flexible to enable scientists and technologists to utilize their full potential for R&D work while searching for a job. The SRAs have the freedom to choose a research project and join an Institute/R&D organization of their preference where facilities are avail-

able to carry out the selected research proposal. The scheme has been made very liberal to enable them to get absorbed in suitable jobs in India. The SRAs are entitled to send any number of applications against advertised or otherwise posts in their field. In case of securing temporary or ad-hoc posts, they are allowed to go on secondment leave for a maximum period of one year. They can leave the pool at any time during the tenure of SRAship. They can also avail of three months' extraordinary leave (EOL) for some personal reasons. The SRAs who left the pool scheme after availing of the partial tenure, are allowed to apply again for the balance period of three years.

As many as 19,420 SRAs were selected to the Scientists' Pool scheme from 1959 to 1996 and 10,024 SRAs benefitted by joining the pool during the same period. The remaining selectees did not join the pool, probably they had better employment opportunities either in India or abroad. As the practice stands, the SRAs are selected through the Special Recruitment Board meetings held regularly after every three to four months and then many of those selected join the scientists' pool. At the exit end those who availed three years or got employment at various stages of the tenure resign and go out of the pool. Thus, there are always 350-400 SRAs working in the pool at a given point of time.

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The Human Resource Development group (HRDG), CSIR has been regularly maintaining statistical data on the candidates who got selected and joined the pool and conducting studies on their various characteristics and analysing trends. There have been 899 SRAs who left the pool after serving full or partial tenure during 1991–1995. The present study has been undertaken to bring out the various characteristics of these SRAs. The records of these SRAs have been scanned thoroughly and relevant data on subject-wise distribution, organizations of placement, the countries from where they acquired qualification/training, etc. have been collected and collated. Tables 1–5 and Figures 1–3 present data on various characteristics of the SRAs.

### Year-wise and subject-wise distribution

Table 1 shows year-wise and subject-wise distribution of the SRAs who left the pool during the period 1991 to 1995. The maximum number of SRAs, i.e. 490 belong to the medical sciences group followed by the natural sciences group whose number is 330. The percentages of SRAs belonging to medical sciences and natural sciences groups were 54.5% and 36.7% respectively. The remaining 79 SRAs from engineering and technology and social sciences group together constitute 8.8%.

**Table 1.** Year-wise and subject-wise distribution of the SRAs who left the pool during 1991–1995

Subject group	No. of SRAs					Total
	Year of leaving the pool					
	1991	1992	1993	1994	1995	
Natural sciences	86	65	59	60	60	330
Medical sciences	121	126	98	80	65	490
Engineering and technology	13	15	12	7	7	54
Social sciences	6	10	8	1	0	25
<b>Total</b>	<b>226</b>	<b>216</b>	<b>177</b>	<b>148</b>	<b>132</b>	<b>899</b>

### Subject-wise distribution of the SRAs returning from abroad

Table 2 shows the distribution of SRAs according to countries from where they acquired the qualification/training for the five-year study period. Table 3 gives the year-wise percentage distribution of the SRAs who obtained qualifications/training in India and abroad. Of the total 899 SRAs joining the scheme, 31.8% were trained abroad. Figure 1 shows year-wise and subject-wise percentage distribution of the SRAs trained abroad. The foreign-trained SRAs belonging to engineering and technology group constitute the highest percentage in comparison to other subjects. However, the percentage of the engineering and technology SRAs dropped from 91.7% in 1991 to 66.7% in 1995. The next highest percentage is from the stream of natural sciences which varied from 63.5% to 43.2% during the same period. For the medical sciences group, the percentages of SRAs trained abroad have been 15.7% in 1991 and 11.6% in 1995, although in 1994 the figure rose to 17.8%. There is a sharp decline of percentages of SRAs belonging to social sciences group which was 50% in 1992, came down to 25% in 1993 and thereafter no foreign-trained social scientist joined the scheme during the period under study. In general, the number of foreign-trained S&T personnel joining the scheme has been on the declining trend.

### Placement of the SRAs

Table 4 shows the distribution of the SRAs according to placement in the type of organizations after their selection. The SRAs were generally placed in universities, CSIR and other R&D organizations, medical colleges and hospitals, industry and other government organizations. Out of the 899 SRAs, 493 were placed in medical colleges and hospitals followed by 245 in universities and colleges, and 146 in CSIR and other R&D organizations. The 97% of the medical SRAs' obvious choice for placement was hospitals and other medical research institutes. Further, the 55% of SRAs of natural science group were placed in universities, 27.0% in CSIR and

**Table 2.** Subject-wise distribution of the SRAs trained in India and abroad

Subject group	Country										Foreign total	Total
	India		USA		UK		USSR		Other countries			
	No.	%	No.	%	No.	%	No.	%	No.	%		
Natural sciences	162	49.1	68	20.6	18	5.5	8	2.4	74	22.4	168	330
Medical sciences	423	86.3	5	1.0	24	4.9	3	0.6	35	7.2	67	490
Engineering and technology	10	18.6	14	25.9	6	11.1	6	11.1	18	33.3	44	54
Social sciences	18	72.0	1	4.0	0	0.0	5	20.0	1	4.0	7	25
<b>Total</b>	<b>613</b>	<b>68.2</b>	<b>88</b>	<b>9.8</b>	<b>48</b>	<b>5.3</b>	<b>22</b>	<b>2.4</b>	<b>128</b>	<b>14.3</b>	<b>286</b>	<b>899</b>

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11.5% in other R&D organizations. A noteworthy point regarding SRAs of engineering and technology group is that the 57.4% of them joined in universities and colleges, 26% in CSIR and other R&D organizations and their placement in industry was surprisingly as low as 5.5%. The percentages of SRAs of other subject groups joining

the industry were also very low. In view of the liberalization and globalization of Indian economy, the job potential for S&T personnel is expected to be higher in Indian industry and their R&D establishments. Therefore, the SRAs may be encouraged to make efforts to join various industries so that the prospects of their

Table 3. Subject-wise and year-wise percentage distribution of the SRAs trained in India and abroad

Subject group	Year of leaving the pool									
	1991		1992		1993		1994		1995	
	India	Abroad	India	Abroad	India	Abroad	India	Abroad	India	Abroad
Natural sciences	36.5	63.5	50.7	49.3	48.0	52.0	61.0	39.0	56.8	43.2
Medical sciences	84.3	15.7	86.9	13.1	88.8	11.2	82.2	17.8	88.4	11.6
Engineering and technology	8.3	91.7	20.0	80.0	9.1	90.9	25.0	75.0	33.3	66.7
Social sciences	75.0	25.0	50.0	50.0	75.0	25.0	100.0	0.0	100.0	0.0
Total	64.1	35.9	70.5	29.5	71.8	28.2	68.8	31.2	69.9	30.1

Table 4. Placement of the SRAs in various organizations

Subject group	Organization												Total
	Univ./colleges		CSIR		Other R&D orgn		Med. college & hospital		Industry		Other govt orgn		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Natural sciences	183	55.5	89	27.0	38	11.5	13	3.9	2	0.6	5	1.5	330
Medical sciences	8	1.6	0	0.0	4	0.8	478	97.6	0	0.0	0	0.0	490
Engineering and technology	31	57.4	11	20.4	3	5.6	2	3.7	3	5.5	4	7.4	54
Social sciences	23	92.0	0	0.0	1	4.0	0	0.0	0	0.0	1	4.0	25
Total	245	27.3	100	11.1	46	5.1	493	54.8	5	0.6	10	1.1	899

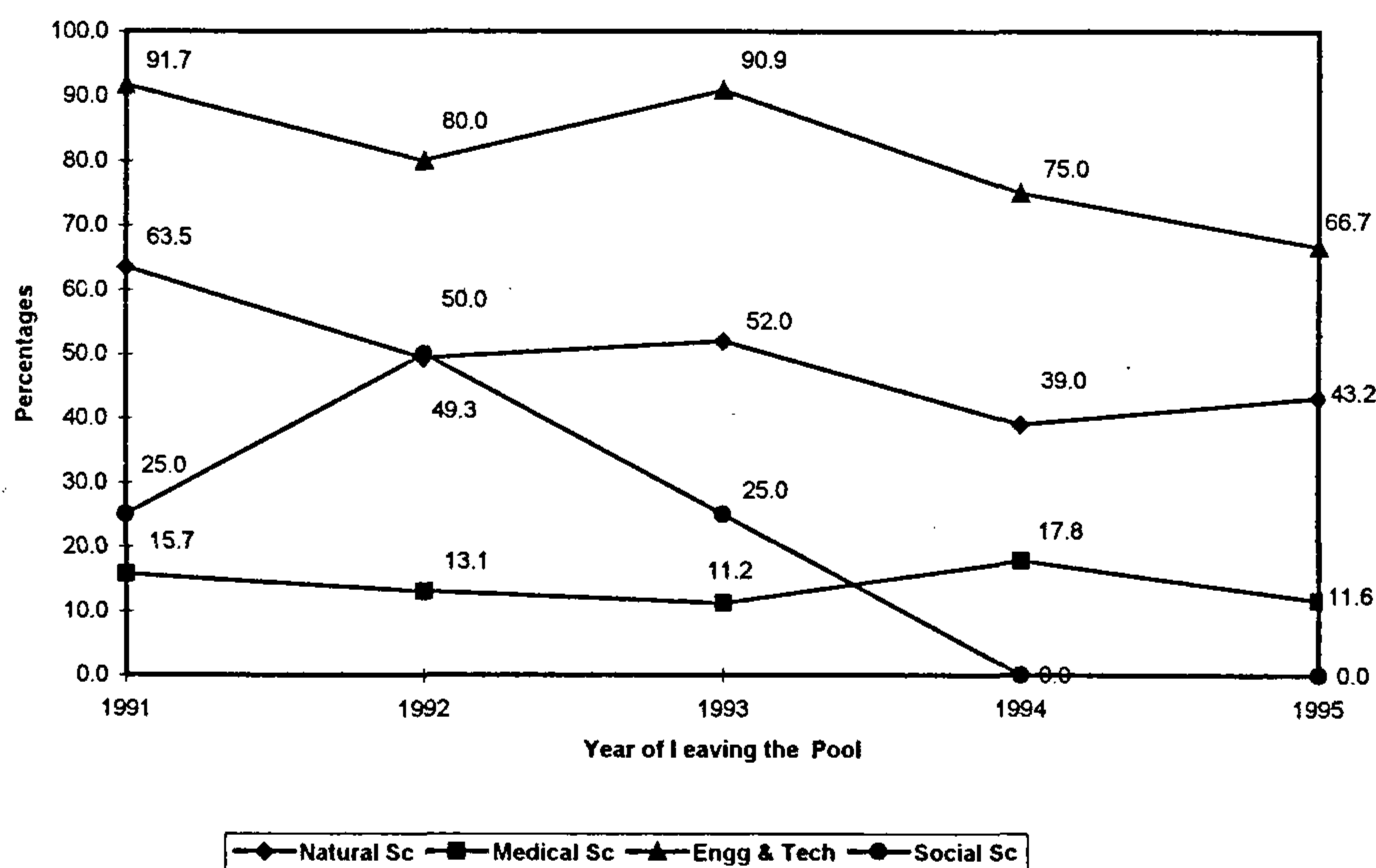


Figure 1. Subject-wise and year-wise percentages of SRAs trained abroad.



securing jobs are enhanced. In this direction CSIR is contemplating suitable measures such as involving industry representatives in SRAs selection etc.

### Average stay of SRAs in the pool

Figure 2 displays the average stay of SRAs of various subject groups in the pool. Eighty per cent of the SRAs belonging to social sciences group and 53% of the natural sciences group stayed for a full tenure of 36 months, whereas percentages of SRAs of the medical sciences and engineering and technology groups staying for the same period were 28 and 27 respectively. The 12% of the SRAs of both medical sciences and engineering and technology groups, 6% of natural science and 4% of social sciences groups stayed in the pool for less than 6 months which is the shortest period of stay in the pool. It is obvious that social sciences and natural sciences groups had lower job opportunities leading to SRA's longer stay in the pool. Figure 3 presents breakup of average stay of SRAs belonging to natural sciences group, in terms of individual subjects, e.g. physics, chemistry, mathematics, life science and earth science. Seventy per cent of the SRAs specialized in earth science have stayed in the pool for full tenure which is the highest percentage, indicating lowest job opportunities for this group, whereas 36% of the physics SRAs have stayed for full tenure in the pool which is lowest percentage in natural science group. Nine per cent of the SRAs having specialization in physics stayed in the pool for less than 6 months when compared to

7% in mathematics, 6% in earth sciences, and 5% in each chemistry and life science. The persons having specializations in physics and chemistry had better employment opportunities when compared to other subjects in the natural sciences group.

### Placement of SRAs vs employing organizations

Table 5 displays the SRAs' initial placement vs organizations where they got employment after leaving the pool. The information regarding employment after the SRAship has been collected from the records available, and it was available only for 376 SRAs out of 899. The remaining 523 ex-SRAs did not provide any information in this regard. The analysis of the data indicates that out of 94 SRAs placed in universities and colleges, 68.1% were absorbed in the same sector whereas 10.6% got employment in other R&D organizations. Out of 31 SRAs placed in CSIR, 51.6% were absorbed in CSIR, 19.4% in university systems and 22.6% left for abroad. The SRAs placed in other R&D organizations were 17, out of which 35.3% got job in university systems, 5.9% in CSIR and 29.4% in other R&D organizations. Out of 230 SRAs placed in medical colleges and hospitals, 59.1% of them got absorbed in medical sector, 7.4% in other government organizations, 12.2% were self-employed and 15.2% left for abroad. The statistics regarding employment of SRAs indicate much higher percentage of SRAs could get employment in the sector of their placements. One interesting point to note is that 22% of the SRAs working in CSIR could get

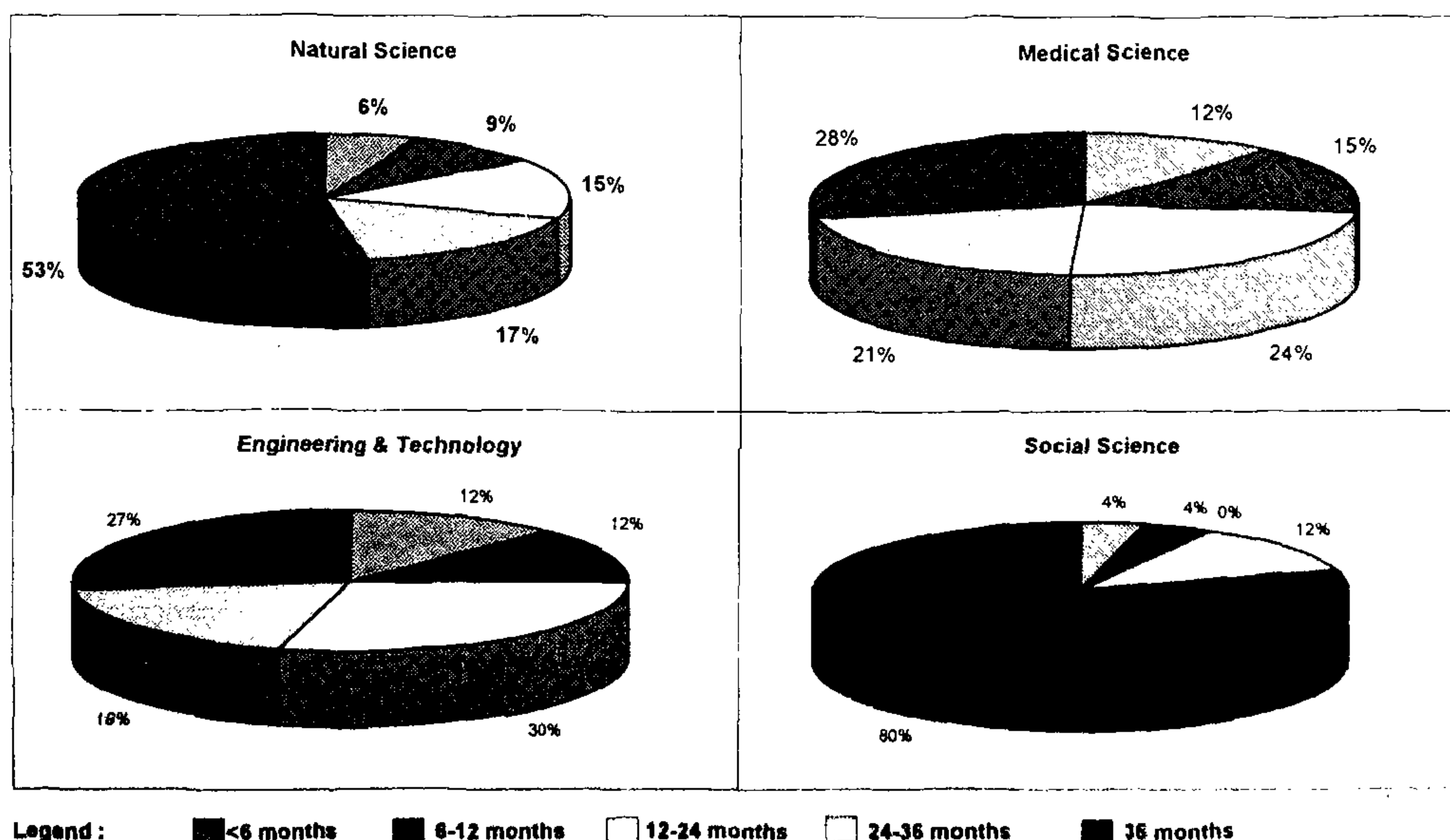


Figure 2. Average stay of SRAs in the pool (in months).

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opportunity of leaving for abroad for better prospects whereas 15.2% of the SRAs working in medical colleges and hospitals left for abroad. The data on placement in relation to ultimate absorption in regular employment provide an insight into the choices made by the candidates at the time of joining SRAship.

### Other characteristics

Although the maximum age limit for candidates applying for SRAship is 40 years, this study indicates that the

average age of SRAs at the time of joining the pool was only 33 years. The subject group-wise breakup shows that the average age of the SRAs at the time of joining the pool was 34 years for natural sciences, 31.9 years for medical sciences, 32 years for engineering and technology and 35 years for social sciences group.

Overall male/female-wise ratio of the SRAs was 2.3 : 1. Subject group-wise analysis reveals that male/female ratio is 1.7 : 1 for natural sciences, 2.8 : 1 for medical sciences, 23 : 1 for engineering and technology and 1 : 1 for social sciences group.

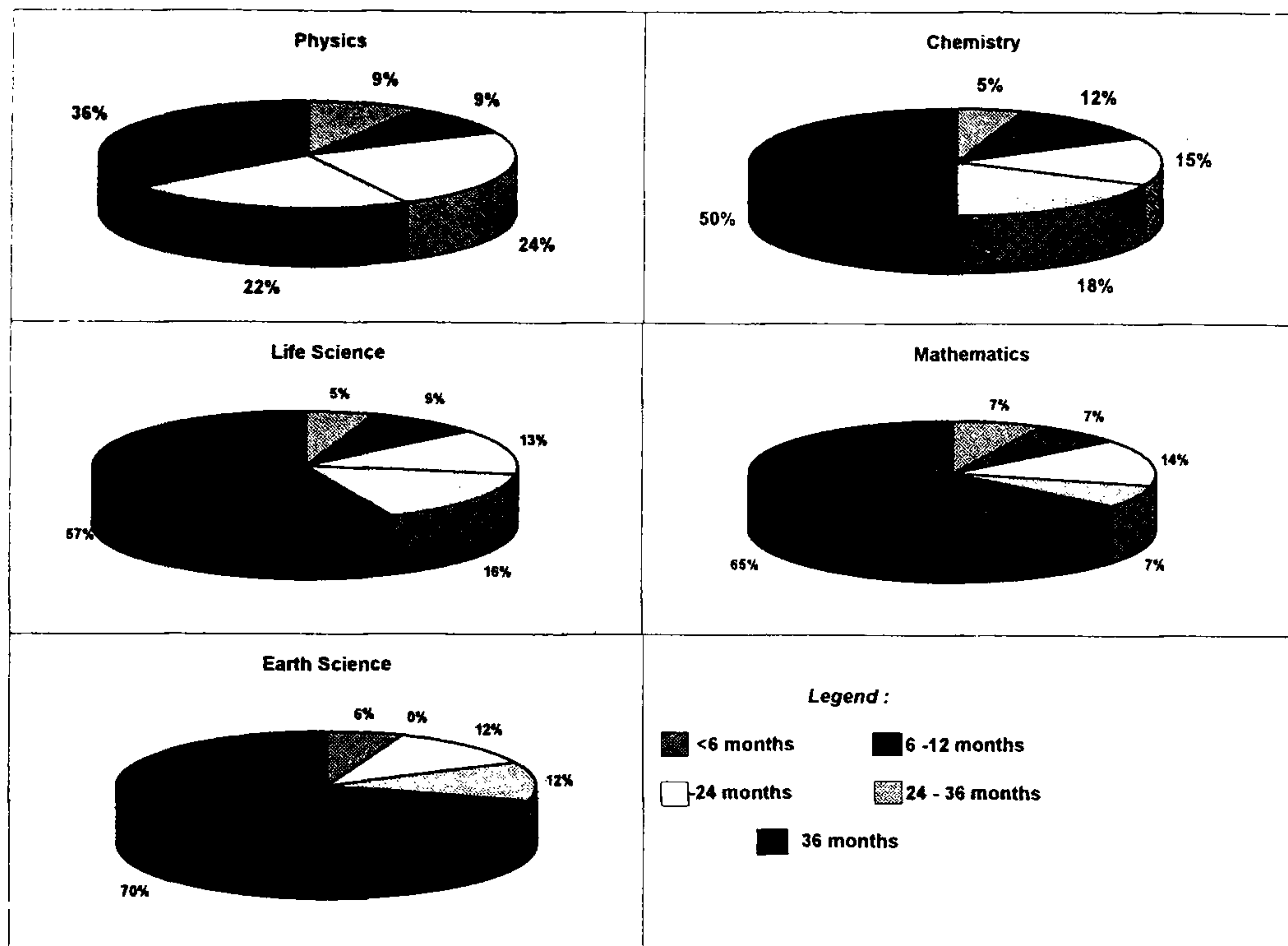


Figure 3. Average stay of SRAs in the pool (in months). Breakup of the natural sciences group.

Table 5. Placement of SRAs vs employing organizations (%) (Table relates the SRAs who have reported having obtained employment)

Pool placement	No. of SRAs	Organizations where the SRAs got employment after leaving the pool								
		Univ./college	CSIR	Other R&D orgn	Med. college & hospital	Industry	Govt orgn	Other orgn	Self-employment	Left abroad
Univ./college	94	68.1	2.1	10.6	0.0	7.4	3.2	2.1	0.0	6.4
CSIR	31	19.4	51.6	3.2	0.0	3.2	0.0	0.0	0.0	22.6
Other R&D orgn	17	35.3	5.9	29.4	11.8	11.8	5.9	0.0	0.0	0.0
Med. college & hospital	230	1.7	0.0	2.2	59.1	1.7	7.4	0.4	12.2	15.2
Industry	1	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Govt orgn	3	33.3	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total</b>	<b>376</b>	<b>21.5</b>	<b>5.1</b>	<b>6.1</b>	<b>36.7</b>	<b>4.0</b>	<b>5.6</b>	<b>0.8</b>	<b>7.4</b>	<b>12.8</b>

## Research publications

The research productivity of 234 SRAs who availed full tenure of 36 months in the pool was analysed during the period of study. A total of 290 research papers had been published, 92 papers had been accepted for publication and 163 papers were communicated to various national and international journals by these SRAs. Further, 11 patents were filed by these SRAs during this period.

## Conclusion

In the last 40 years, the Scientists' Pool scheme has offered opportunity to over 19,000 highly qualified Indian S&T personnel and over 10,000 had joined the pool to utilize their research potential and simultaneously look for regular positions. The scheme has been made flexible in nature for allowing the SRAs to join the institutions

of their choice and pursue a research proposal conceived by them. Majority of the SRAs succeeded in getting absorbed in the sectors of their placement. The study indicates that the SRAs are to be encouraged to join the industrial sector in order to improve their employment prospects. The research output of the SRAs has been appreciable. Over the years many SRAs<sup>1</sup> acquired eminent positions and attained the level of Directors in various R&D organizations and Professors or equivalent positions in various universities and other institutions of higher learning. The scheme has proved to be an effective instrument in developing and providing continuously a band of trained R&D scientists and technologists to the nation.

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# The origin of adaptive mutations: Explaining the mutational spectra of Lac<sup>+</sup> revertants of the *Escherichia coli* strain FC40

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*Reversion of lacI33-lacZ frameshift mutation to produce Lac<sup>+</sup> colonies takes place by demonstrably different mechanisms in growing and starving cultures of strains (such as FC40) harbouring this mutation. The revertants appear to arise in starving cells only under conditions where they can immediately promote growth. This is reminiscent of Lamarckism. Here we propose a mutagenic mechanism which is Darwinian inasmuch as it is blind to the adaptive fitness of the mutants but can explain the mutational spectra seen in FC40 and certain other strains. This mechanism can produce mutations only in the neighbourhood of a methylatable cytosine.*

SINCE the Darwinian theory of evolution freed biology from all transcendence and did not require living organisms to have any mysterious properties unexplained by the chemical properties of their constituents, it found ready scientific acceptance (in spite of considerable opposition from certain non-scientific quarters) and by 1930s it became almost the universally accepted theory of evolution, at least as far as the evolution of higher organisms was concerned. However, microorganisms seemed to be somewhat exceptional because they very

rapidly adapted to changing environments, suggesting a possible role for environment in producing specific (directed) mutations which could increase the fitness of the organisms. In 1940s the fluctuation analysis of Luria and Delbruck and other experiments based on sib selection and replica plating showed that bacterial mutants which survived a lethal environmental change were largely produced before the population was exposed to the lethal challenge (see ref.1 for a detailed discussion). These mutations, therefore, could not have been directed by the new environment. Since these results were consistent with the Darwinian theory, bacteria were admitted into the fold of neo-Darwinism, in spite of a warning

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