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Chapter Five

The Citation Index as a Search Tool

The introduction of *SCI* in 1964 was the first large-scale attempt to apply the citation-indexing concept to the problem of searching the scientific literature. Unfamiliar and unconventional as *SCI* was in terms of its organization and search methodology, it established itself rather quickly as an important literature-retrieval tool: librarians and scientists found that it identified a high percentage of the material published on a given subject and that a high percentage of what it identified was pertinent.

While many factors account for the rapid adoption of *SCI,* the most significant is the *Citation Index* and its use of reference citations as indexing terms. That single feature gives a citation index three unique functional characteristics that have a significant impact on search productivity and efficiency (see Chapter One). The first is a subject categorization of published material that is, semantically, both more precise and detailed. It is also semantically more stable and flexible than conventional subject indexing.

The other two characteristics are a matter of perspective. Citation indexing goes beyond the function of categorizing the literature. It explicitly reveals the intellectual relationships that exist between old and new literature. Each article is a published record of a particular event in the process of scientific development. The citation index shows the relationships between individual events at different points in time. That makes a citation index particularly effective in telling us what has happened to some idea or experiment—whether it has been confirmed, extended, improved, tried, or corrected.

The third characteristic stems from the second. The citation index focuses our attention on the relationships between scientific events. These relationships can, and frequently do identify the otherwise hidden linkages between events that make up what we call disciplines and specialties. Thus citation indexing inherently classifies the literature it covers.

The two characteristics of perspective, plus the semantically different and often

superior method of categorizing material make the literature covered by a citation index highly accessible. Indeed, as the literature coverage becomes more comprehensive and multidisciplinary, the citation index becomes increasingly useful.

SAMPLE SEARCHES

In the absence of any truly definitive test of the search performance of a citation index, the best way of demonstrating its utility is by showing what some typical searches require in effort and produce in results (1–3). The following discussion does that, with a series of 10 sample searches conducted in *SCI*. Where appropriate, diagrams are used to show the search graphically (4). Each of the numbers in the diagrams represents a single paper, which may be either a reference citation (used as an indexing term to identify relevant papers), a source citation (identified as having cited a particular paper), or both (once a paper has been identified and judged, by the user, to be relevant, it can be used as a reference citation to extend the search). The arrows indicate the direction of the search from citation to citation. The dots represent a connection between the horizontal and vertical lines linking two citations. The year shown to the right of each citation is the year of publication; in the case of source citations, that year usually corresponds to the *SCI* edition in which the paper was identified, except for those instances when the journal issue involved was published too late to include in the proper edition. The citations listed beside the diagram are the *Source Index* descriptions of papers initially identified in the *Citation Index* lookup.

Bibliographic-Verification Search

Probably the most common type of search is the one concerned with citation verification. It may be a document that is cited in a manuscript being prepared for publication. Or it may be a paper that has been requested on an interlibrary loan. Verification is a major function in every scientific library. This type of search is limited when compared to the scope of the usual literature search. The objective is simply to find a known document. All that is required is to make sure that the document actually exists and to get an accurate, complete bibliographic description of it.

To see how a citation index performs on this kind of search, consider a librarian who has been asked to fill in a reference for a researcher writing a review paper on radioimmunoassays of estradiols, a class of hormonal steroids. The only information supplied is that the reference is to an article by G. E. Abraham in the *Journal of Clinical Endocrinology*. The researcher remembers neither the article title nor the year it was published.

The librarian's first job is to make sure the researcher's memory is accurate—that such a paper actually does exist. This is done by looking in the *Citation Index* of the 1975 edition of *SCI* under the name of Abraham, G. E. It identifies a sizable number of papers published by G. E. Abraham that were cited during 1975. Seven of them were published in the *Journal of Clinical Endocrinology*.

The next step in the search is to obtain the full citations of the seven from the

Source Index of the *SCI* editions involved (1969, 1971, 1972, and 1973). As shown in the sample that follows, those citations explicitly tell the librarian, by their titles, that the first six papers deal with radioimmunoassay work. The seventh may or may not, since the measurement technique is not identified in the title. Two of the six (#1 and #2) also specifically identify estradiol compounds in their titles, so one of them is likely to be the paper that the researcher wants to verify. Paper #7 also is a possibility, because estradiol may be one of the classes of steroids measured. The librarian probably would send the researcher all three citations. One almost certainly would be the missing reference; either, or both, of the other two might be useful additional references that the researcher will want to include.

1. ABRAHAM GE
   Solid-Phase Radioimmunoassay of Estradiol-17Beta
   J CLIN END 29 866 69 N 23R

2. ABRAHAM GE
   ODELL WD SWERDLOF RS HOPPER K—Simultaneous Radioimmunoassay of Plasma FSH, LH, Progesterone, 17-Hydroxyprogesterone, and Estradiol-17 Beta During Menstrual Cycle
   J CLIN END 34 312 72 49R N2

3. ABRAHAM GE
   SWERDLOF R TULCHINS D ODELL W—Radioimmunoassay of Plasma Progesterone
   J CLIN END 32 619 71 12R N5

4. ABRAHAM GE
   SWERDLOF RS TULCHINS D HOPPER K ODELL W— Radioimmunoassay of Plasma 17-Hydroxyprogesterone
   J CLIN END 33 42 71 8R N1

5. ABRAHAM GE
   BUSTER JE KYLE FW CORRALES PC TELLER RC— Radioimmunoassay of Plasma Pregnenolone, 17-Hydroxypregnenolone and Dehydroepiandrosterone Under Various Physiological Conditions
   J CLIN END 37 140 73 N 15R N1

6. ABRAHAM GE
   BUSTER JE KYLE FW CORRALES PC TELLER RC— Radioimmunoassay of Plasma Pregnenolone
   J CLIN END 37 40 73 13R N1

7. ABRAHAM GE
   CHAKMAKJ ZH—Serum Steroid Levels During Menstrual-Cycle in a Bilaterally Adrenalectomized Woman
   J CLIN ENDOCR 37 581 73 26R N4

1. DONNAN FG
(GE) A THEORY OF MEMBRANE EQUILIBRIUM AND MEMBRANE POTENTIAL IN THE PRESENCE OF NON-DIALYZED ELECTROLYTES. A CONTRIBUTION TO PHYSICAL-CHEMICAL PHYSIOLOGY
Z ELEKTROCHEM 17:572 11

2. ALEKSEEV OL
(RS) STUDIES IN ELECTROOSMOSIS - CONDITIONS OF APPLICABILITY OF DONNAN EQUILIBRIUM FOR DETERMINATION OF EXCESS IONS CONCENTRATION IN ELECTRIC DOUBLE-LAYER
KOLL ZH 35(4):726 73 N 9R

3. BARKER SA
BURNS RF - REACTOR SEPARATORS INCORPORATING MEMBRANE-BOUND ENZYMES
CHEM IND L 1973(16):801 73 N 11R

4. DOBOZY OK
EXPLANATION OF MORDANT DYEING USING ELECTRONIC THEORY
AM DYE REP 62(3):36 73 58R

5. GHOSH BN
COLLOIDAL ELECTROLYTES - ATTEMPT TO ACCOUNT FOR OSMOTIC PRESSURE OF SOLS OF GUM ARABIC WHEN CONCENTRATION OF GUM AND THAT OF DIFFUSIBLE ELECTROLYTES ADDED VARY
J IND CH S 50(2):114 73 9R

6. HOORNAER. P
LEFEBVRE C VANHAUTE A - HYPERFILTRATION BY DYNAMICALLY FORMED HYDROUS ZIRCONIUM OXIDE AND ALUMINUM-OXIDE MEMBRANES
DESALINATN 11(3):315 72 12R

7. JANOSOVA J
SENKYR J BARTUSEK M - (CZ) ANALYTICAL USE OF SILVER-IODIDE MEMBRANE ELECTRODE
CHEM LISTY 67(8):836 73 10R

8. TAMAMUSH. R
EXPERIMENTAL STUDY OF GIBBS-DONNAN MEMBRANE EQUILIBRIA ACROSS PERMSELECTIVE MEMBRANES WHICH INVOLVE IONS OF STRONG INORGANIC ELECTROLYTES
B CHEM S J 46(9):2701 73 44R

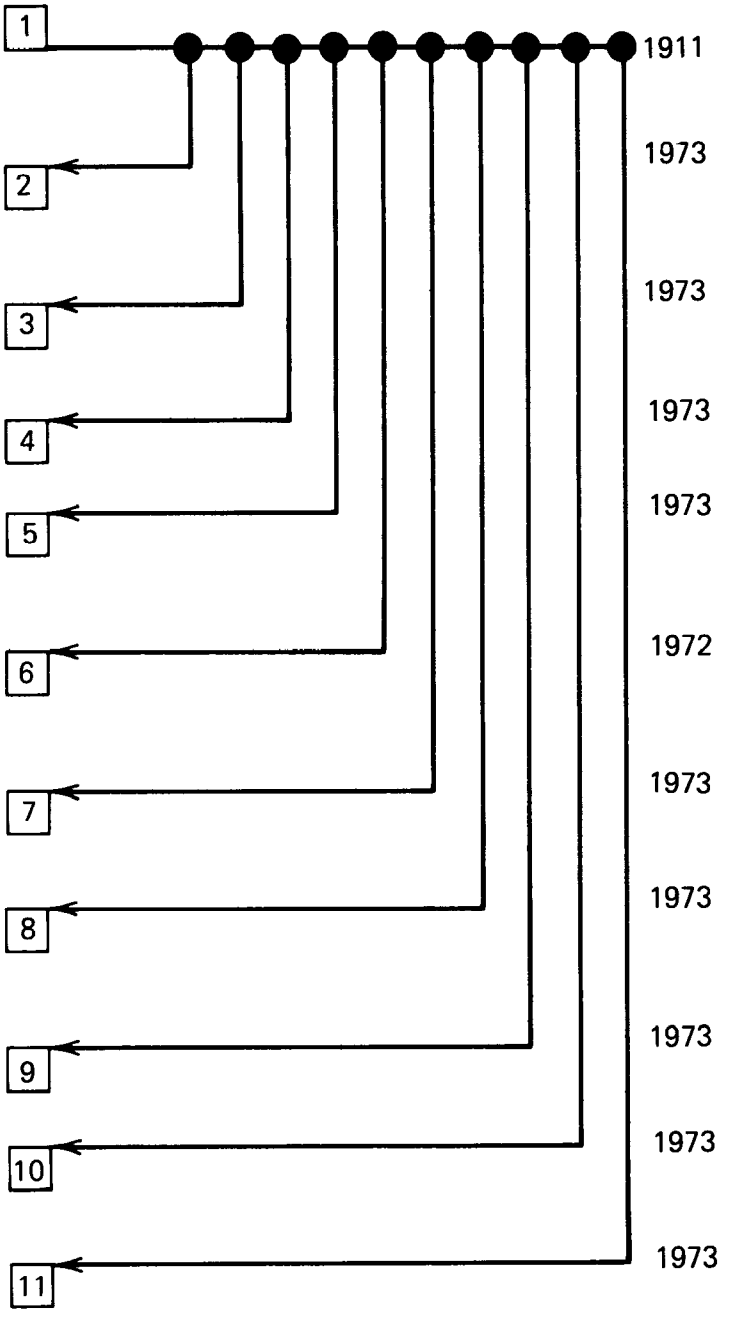
9. MCNICHOL. B
IRISH BLOOD - AND ELECTROLYTES
J IRISH MED 66(14):388 73 26R

10. WEISS RL
MORRIS DR - CATIONS AND RIBOSOME STRUCTURE .1. EFFECTS ON 30S SUBUNIT OF SUBSTITUTING POLYAMINES FOR MAGNESIUM ION
BIOCHEM 12(3):435 73 44R

11. WUHRMANN HR
MORF WE SIMON W - (GE) MODEL CALCULATION OF EMF AND ION SELECTIVITY OF MEMBRANE ELECTRODE MEASURING CHAINS
HELV CHIM A 56(3):1011 73 60R

Figure 5.1 Eponymic search using *Citation Index*.

This search illustrates an important characteristic of *SCI*. Any annual edition contains, in the *Source Index*, a sizeable percentage of the significant papers published that year. But the *Citation Index* will contain a large percentage of the significant papers published in previous years. If one accepts the premise that a paper of even minor significance is cited at least once in 10 years, a 10-year span of *SCI*, two five-



year cumulations, contains the citations of literally all the significant scientific literature that is known to exist. A single five-year cumulative edition of *SCI*, covering 1965–1969, contains approximately 6.4 million reference citations. A study conducted by Williams and Ping (5) showed that this was a large-enough percentage of the significant literature to include every one of almost 300 biomedical papers that were chosen at random for verification.

Eponymic Search

An eponymic search is one that involves information on a subject that is named for a person. The practice is quite common in physics, astronomy, chemistry, and, of course, in medicine. Diseases are frequently named for the people who initially discovered or defined them. Hodgkins disease and Bell's palsy are two examples. The problem with searching a subject given an eponymic name is that the name may not be accepted universally as an indexing term. In that case, material on the subject would be identified by generic terminology. Exactly what that terminology may be is something the researcher must determine, usually by trial and error. A citation index frequently enables a researcher to avoid this type of guessing exercise. All he does is use the citation of the primordial paper associated with the eponymic name as a search term. If the paper is not so fundamental that the practice of formal citation has been obliterated, the search generally identifies one or more relevant papers in a single lookup.

For example, consider a researcher doing studies on electro-osmosis. He wants to find out if, and what, work relevant to his own has been done with the Donnan equilibrium theory. The theory predicts the speed and rate at which ions migrate through a permeable membrane. Figure 5.1 shows what is involved in a citation search to answer that question. Using the original paper in which Donnan describes his theory (#1 in Figure 5.1) for a search of the *Citation Index* of the 1973 *SCI,* the researcher finds the 10 citing papers listed in Figure 5.1 (#2 through #11). Two of them, the papers by Alekseev (#2) and Tamamush (#8) are of obvious interest, just on the strength of their titles. The other eight may or may not be useful; the researcher would have to read them to fine out. If there was any need to continue the search, 53 references cited in the two relevant papers could be used as starting points for additional citation searches.

Methodology Search

Searches for information on methodological techniques have always been difficult in conventional subject indexes. Conventional indexing is based on the "main" theme of an article. The methods used are considered secondary to the "main" theme. On the other hand, authors frequently cite the original papers for the methods they use. This practice, saves authors the trouble of writing detailed explanations of their methods. Consequently a citation index is particularly effective for methodology searches.

Figure 5.2 shows a typical citation search for methodological information. A hypothetical example involves a researcher who is having trouble with the Barland method for isolating surface membranes from tissue-cultured cells. He turns to the literature to find out if his unsatisfactory results are typical or are the result of his applying the technique incorrectly. He looks up the Barland paper (#1 in Figure 5.2) in the *Citation Index* of the 1974 *SCI.* This identifies two papers whose titles are found in the *Source Index.* They describe the use of the method in two different applications. Presumably, they will give the researcher some useful information about

what results to expect from the method, details about its application, or modifications that can make the method more effective.

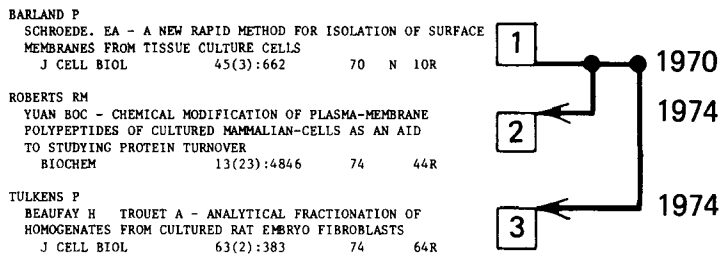


Figure 5.2 Methodology search.

Follow-up Searches

The objective of many literature searches, particularly in the chemical and chemical-processing areas is to follow up an earlier development. Figure 5.3 shows a typical citation search to find out what has been learned about a reaction that involves the metal-hydride reduction of endodicyclopentadienone since it was initially described. The starting point in the search is the citation for the original paper, published in 1970, by W. L. Dilling (#1 in Figure 5.3). The *Citation Index* of the 1974 *SCI* identifies four papers under the reference citation. Their titles show that two of them (#3 and #5) describe the metal reduction of the same, or similar, compound as in the Dilling paper, so it can be assumed that they will be relevant. The other two papers (#2 and #4) would have to be read to determine their relevance.

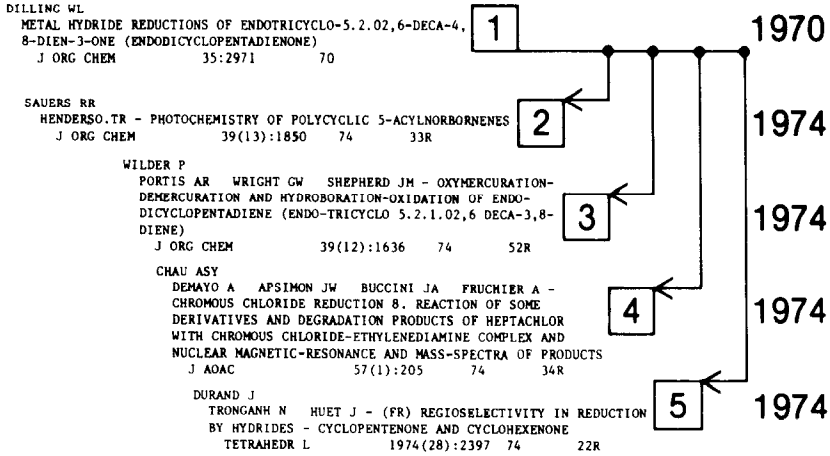


Figure 5.3 Reaction follow-up search.

More extensive and complex is the example, shown in Figure 5.4, of a search to see what follow-up work has been done on a compound, trimethoprim, since it was announced. The search starts in the 1965 *SCI* on the citation for the 1962 announcement paper (#1 in Figure 5.4) and covers a span of nine years. Paper #1 identifies papers #2, #3, #4, #7, #8, #9, #12, #13, #14, and #16 in the 1965–1974 editions of

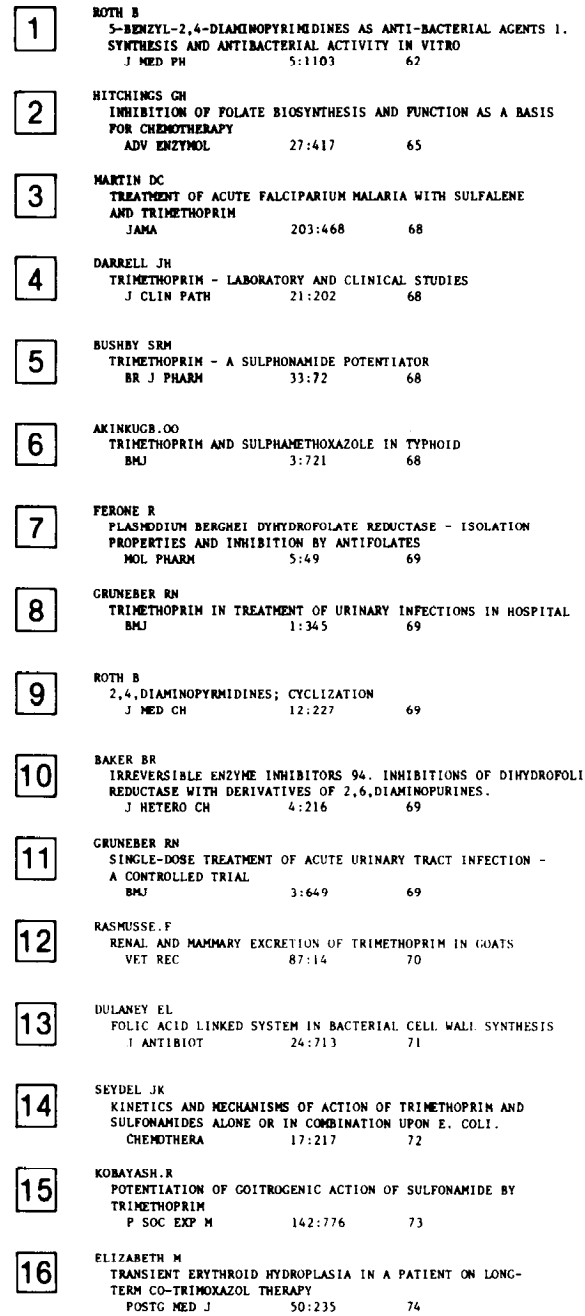
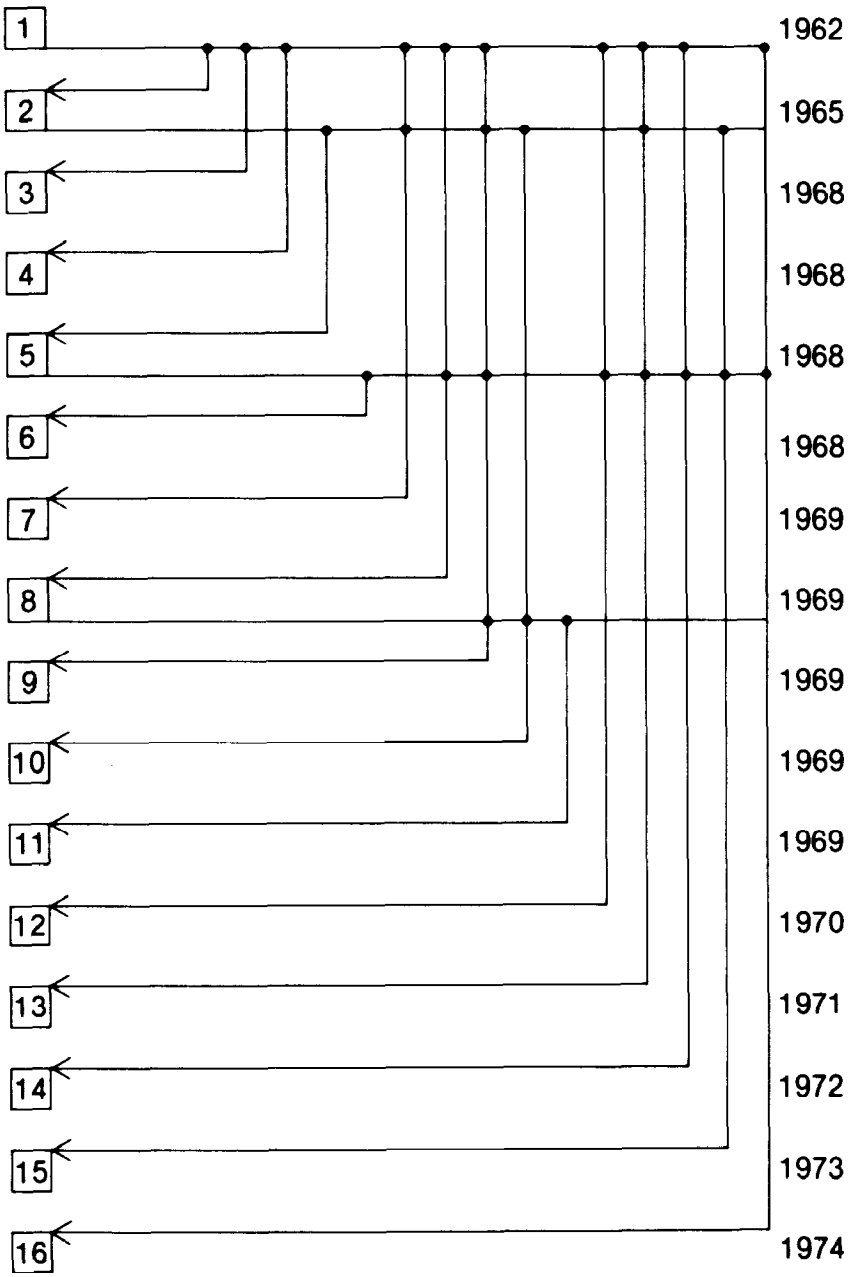


Figure 5.4 Compound follow-up search.

SCI. When the search is continued on paper #2 in the 1966–1974 editions of*SCI,* papers #7, #9, and #13 are identified a second time, and three new papers (*#5,* #10, and #15) are discovered. Searches on papers #3 and #4 during the years 1969 through 1974 produce nothing of interest. A search on paper #5 during the years 1969 through 1974 identifies papers #8, #9, #12, #13, #14, #15, and #16 again and uncovers paper #6 for the first time. Papers #6 and #7 lead to nothing in a search of the



years 1970 through 1974. A search on paper #8 during the years 1969 through 1974 identifies #9 and #10 again and #11 for the first time. Papers #9 through #15 produce no new additions to the bibliography when they are used as search points for the years 1969 through 1974. So the search trail ends, though new ones could be started with likely references selected from any of the papers obtained.

The search results consist of a bibliography of 15 papers. They trace the development of trimethoprim through the typical pharmaceutical stages of defining the

1. BARDEEN JM
   KERR METRIC BLACK HOLES
   NATURE 226(5240):64 70 9R

2. CHANDRAS. S
   DEVELOPMENT OF GENERAL RELATIVITY
   NATURE 252(5478):15 74 17R

3. CHRZANOW. PL
   MISNER CW - GEODESIC SYNCHROTRON RADIATION IN KERR GEOMETRY BY METHOD OF ASYMPTOTICALLY FACTORIZED GREENS FUNCTIONS
   PHYS REV D 10(6):1701 74 46R

4. DEFELICE F
   NOBILI L CALVANI M - BLACK-HOLE PHYSICS - SOME EFFECTS OF GRAVITY ON RADIATION EMISSION
   ASTRON ASTR 30(1):111 74 28R

5. PRESS WH
   BLACK HOLE PERTURBATIONS - OVERVIEW
   ANN NY ACAD 224(DEC14):272 73 38R

6. PAPINI G
   GRAVITATIONAL RADIATION AND ITS DETECTION
   CAN J PHYS 52(10):880 74 157R

7. SHAPIRO SL
   ACCRETION ONTO BLACK HOLES - EMERGENT RADIATION SPECTRUM 3 ROTATING (KERR) BLACK-HOLES
   ASTROPHYS J 189(2):343 74 20R

8. THORNE KS
   DISK-ACCRETION ONTO A BLACK-HOLE 2 EVOLUTION OF HOLE
   ASTROPHYS J 191(2):507 74 19R

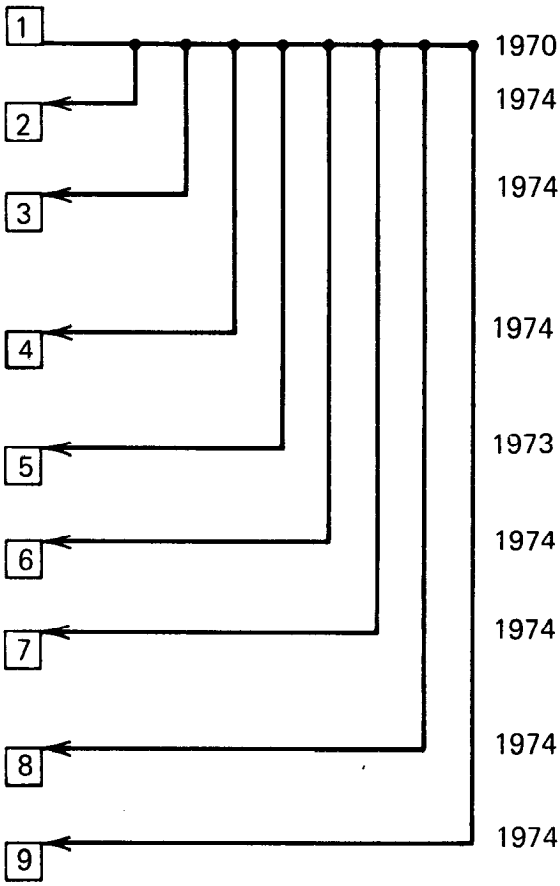
9. WALD R
   GEDANKEN EXPERIMENTS TO DESTROY A BLACK-HOLE
   ANN PHYSICS 82(2):548 74 24R

e 5.5 Concept search.

mechanism of biological activity, in vitro testing, clinical testing, and study of toxicity and side effects.

Concept Search

Figure 5.5 is a typical citation search for information on a concept. Such a search, when possible at all by traditional methods, may require numerous lookups. The variety and changes of terminology in most concepts can be quite tricky. The concept in this example is the use of Kerr geometry to describe the astronomical phenomenon of black holes. The researcher is presumed to know nothing more about the subject of black holes than what he had read in a short paper by J. M. Bardeen that was published in *Nature* in 1970. He is interested in identifying the general literature on black holes, but he is especially interested in the use of Kerr geometry to study the phenomenon. Starting with the only paper he knows, the Bardeen paper (#1 in Figure 5.5), he conducts a simple citation search in the 1974 *SCI.* The *Citation Index* section identifies eight papers, six of which (#3, #4, #5, #7, #8, and #9), from their descriptions in the *Source Index,* seem to be relevant. The other two (#2 and #6)



are at least on related subjects. Since they cite the Bardeen paper, they probably will be useful. Three of the papers (#3, #5, and #6) contain a total of 241 references. These are likely to cover a significant portion, if not all of the literature on both black holes and the role of Kerr geometry in defining them.

Specific Question Search

Searches concerned with answering a specific question usually require sifting through a lot of material. It can be very time-consuming to identify those papers that deal specifically with the question. Figure 5.6 show how a citation index performs on this kind of problem. The question is whether Rae's theory predicting the existence of repetitive DNA sequences has been confirmed. The search is conducted in the 1973 *Citation Index* of *SCI*. The citation for Rae's original paper (#1 in Figure 5.6) is the starting point. Fifteen papers are identified as having cited the Rae paper. Five of them (#3, #8, #10, #12, and #15) have titles that indicate that they are describing repetitive DNA sequences in one type of organism or another. Thus the question is answered, without even consulting the papers themselves.

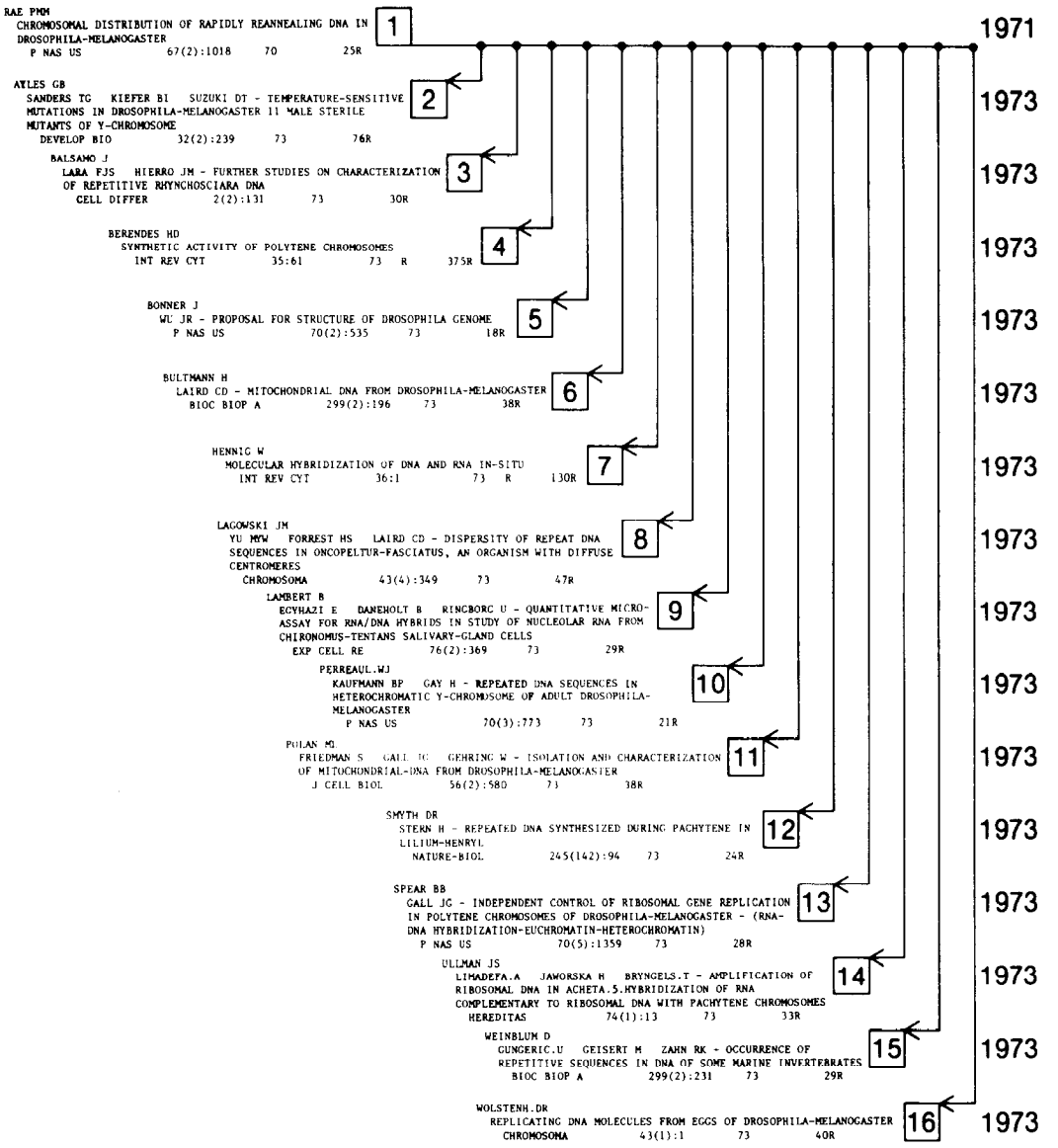


Figure 5.6 Specific-question search.

MultiDisciplinary Search

There are two different types of multidisciplinary searches. The most common is when the search is expected to cover more than one discipline, which usually requires more than one discipline-oriented index. How that kind of search can be handled by a single, multidisciplinary citation index is shown in Figure 5.7.

In this example, a manufacturer of chemical additives that are used for the cryogenic storage of biological material is interested in some basic market research. Specifically, he wants to know if his products are being applied more broadly than expected. He also asks how well they are performing in biological and agricultural

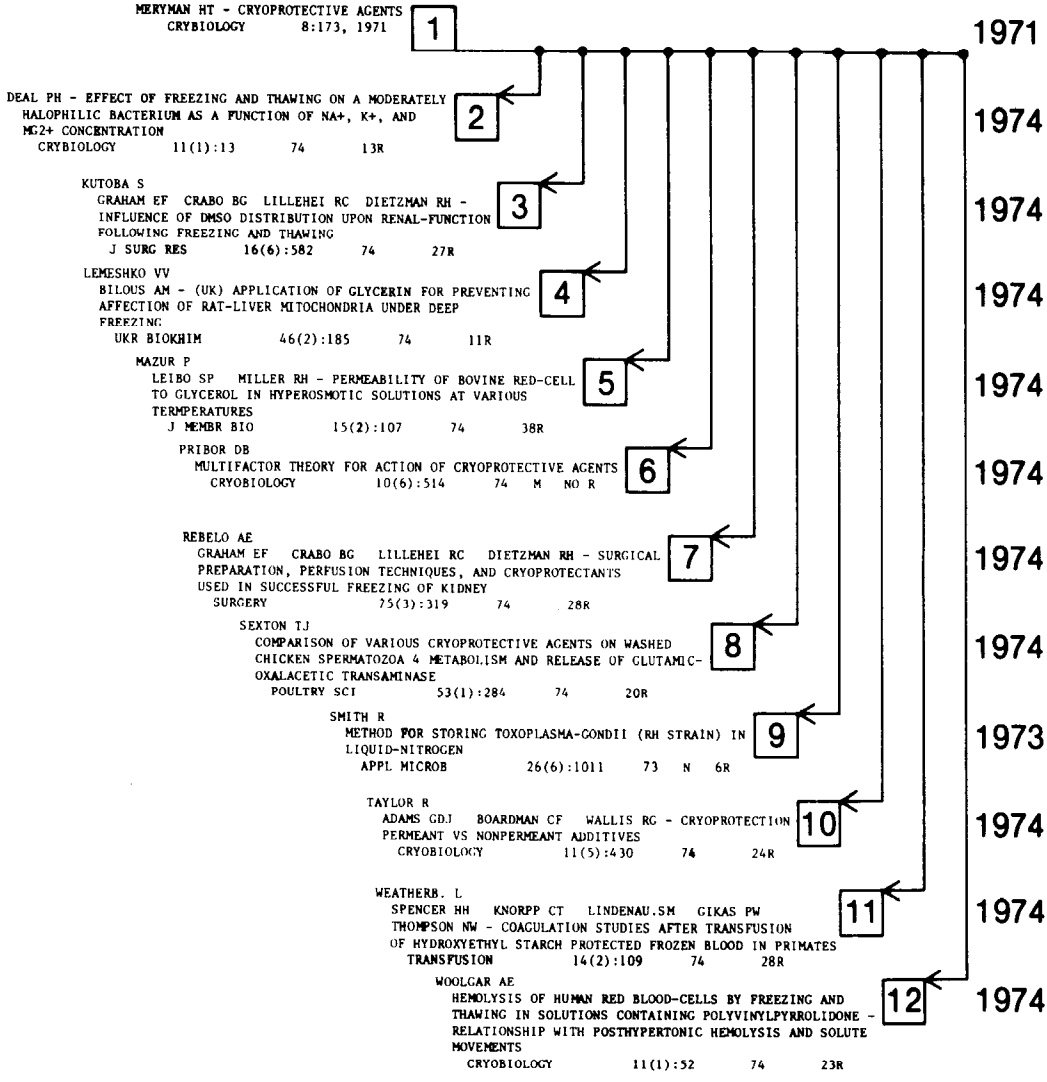


Figure 5.7 Overt multidisciplinary search.

applications. The citation search conducted to answer these questions starts with a single, known paper by H. T. Meryman (#1 in Figure 5.7) that was published in 1971. The 1974 *SCI Citation Index* entry for that paper identifies the 11 citing papers listed in Figure 5.7. The papers identified were published in a fairly broad range of journals: *Cryobiology, Journal of Surgical Research, Ukrainskii Biokhimicheskii Zhurnal, Journal of Membrane Biology, Surgery, Poultry Science, Applied Microbiology,* and *Transfusion.* Moreover, the range of specialties from which the papers come is equally as broad: two are on bacterial storage, two on renal function and the preservation of kidneys, one on mitochondria, three on the preservation and storage of red blood cells, two on the performance of cryoprotective agents, and one on the preservation of sperm.

Finding the same diverse range of papers in conventional indexes would have required separate searches under two or three main subject headings in at least two,

and most likely three, separate indexes. In addition, the selection of appropriate subject headings for each of the searches would have called for a thorough understanding of the linguistic structure of each index. A fair estimate of the time needed to conduct such a search in conventional indexes is three hours. The citation search shown in Figure 5.7 took 20 minutes.

The second kind of multidisciplinary search is one that is focused on the literature of a single discipline or specialty, but that turns out to uncover something useful from outside that literature. This type of search, of course, is unique to a multidisciplinary citation index.

Figure 5.8 is an example of such a search. It might be conducted by a plant geneticist writing a state-of-the-art review of plant hybridization. One of the references he collects is to a 1972 paper by P. S. Carlson on interspecific hybridization, which usually cannot be achieved by conventional sexual methods of reproduction. Using the citation of that paper (#1 in Figure 5.8) as a search term in the 1974 *SCI Citation Index,* the researcher finds 42 papers. Six of them (#12, #20, #23, #24, #25, and #41) have titles that indicate they are on the subject of the genetic fusion of different species. The titles of another seven (#2, #7, #8, #14, #29, #36, and #43) imply that they may deal with the same subject. The remaining 29 papers appear to deal mostly with the techniques of separation, fusion, and regeneration that would have to be perfected before interspecific plant hybrids can actually be created. In reading the papers, he finds that the work has its origins in the viral immunology research being done in molecular biology, a specialty that, until this development, had little to do with applied plant genetics.

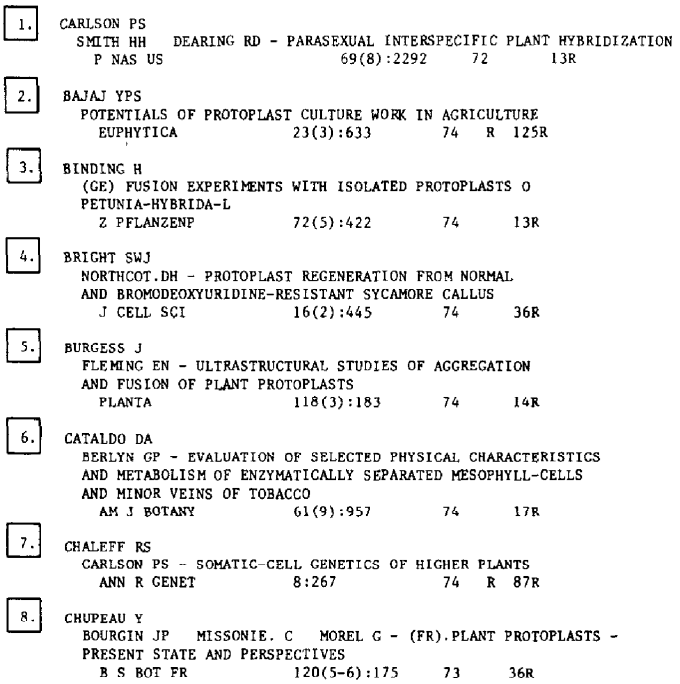
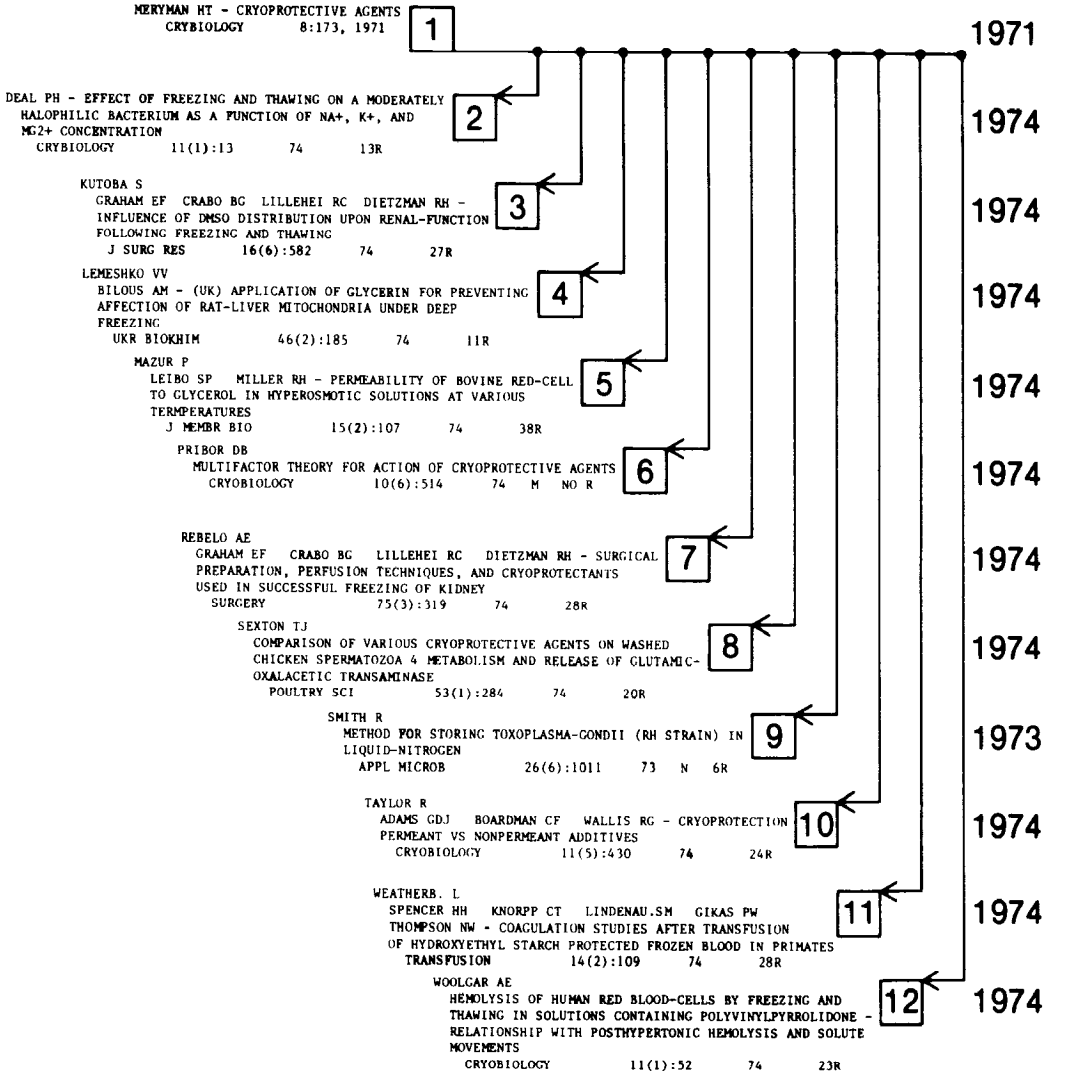


Figure 5.8 Covert multidisciplinary search.



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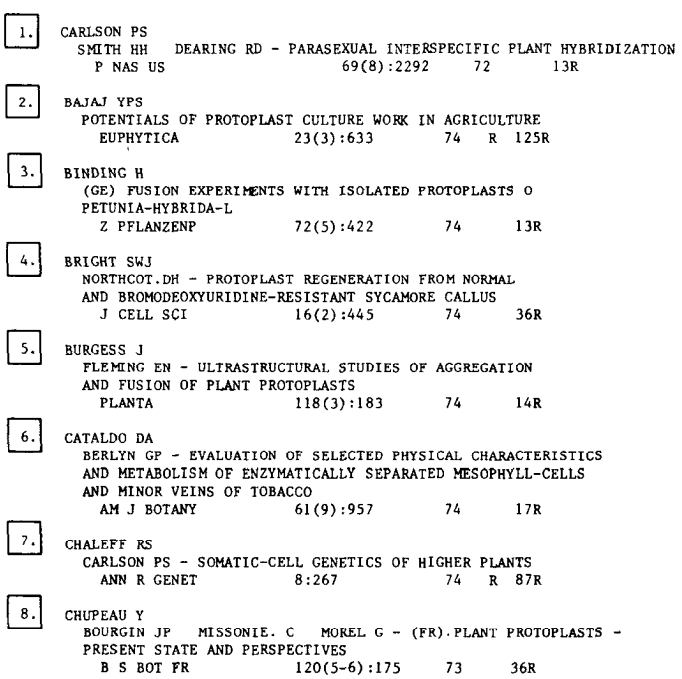

Figure 5.8 Covert multidisciplinary search.

9. CHUPEAU Y
BOURGIN JP MISSONIE. C DORION N MOREL G - (FR)
PREPARATION AND CULTURE OF VARIOUS NICOTIANA PROTOPLASTS
CR AC SCI D 278(12):1565 74 11R

10. COCKING EC
POWER JB EVANS PK SAFWAT F FREARSON EM HAYWARD C
BERRY SF GEORGE D - NATURALLY OCCURRING DIFFERENTIAL DRUG
SENSITIVITIES OF CULTURED, PLANT PROTOPLASTS
PLANT SCI L 3(5):341 74 24R

11. CONSTABE. F
KIRKPATR. JW GAMBORG OL - CALLUS FORMATION FROM
MESOPHYLL PROTOPLASTS OF PISUM-SATIVUM
CAN J BOTAN 51(11):2105 73 8R

12. DULIEU H
COMBINATION OF CELL AND TISSUE-CULTURE WITH MUTAGENESIS
FOR INDUCTION AND ISOLATION OF MORPHOLOGICAL OR DEVEL-
OPMENTAL MUTANTS
PHYTOMORPH 22(3-4):283 72 76R

13. FOWKE LC
BECHHANS. CW GAMBORG OL - ELECTRON-MICROSCOPIC
OBSERVATIONS OF CELL REGENERATION FROM CULTURED
PROTOPLASTS OF AMMI-VISNAGA
PROTOPLASMA 79(1-2):235 74 43R

14. GAMBORG OL
MILLER RA - ISOLATION, CULTURE, AND USES OF PLANT
PROTOPLASTS
CAN J BOTAN 51(10):1795 73 42R

15. GILES KL
COMPLEMENTATION BY PROTOPLAST FUSION USING MUTANT
STRAINS OF MAIZE
PLANT CEL P 15(2):281 74 4R

16. GLIMELIU. K
WALLIN A ERIKSSON T - AGGLUTINATING EFFECTS OF
CONCANAVALIN-A ON ISOLATED PROTOPLASTS OF DAUCUS-
CAROTA
PHYSL PLANT 31(3):225 74 35R

17. GREEN CE
PHILLIPS RL KLEESE RA - TISSUE-CULTURES OF MAIZE
(ZEA-MAYS-L) - INITIATION, MAINTENANCE, AND ORGANIC
GROWTH-FACTORS
CROP SCI 14(1):54 74 36R

18. GROUT BWW
COUTTS RHA - ADDITIVES FOR ENHANCEMENT OF FUSION AND
ENDOCYTOSIS IN HIGHER PLANT PROTOPLASTS - ELECTROPHORETIC
STUDY
PLANT SCI L 2(6):397 74 14R

19. HANKE DE
NORTHCOT. DH - CELL-WALL FORMATION BY SOYBEAN CALLUS
PROTOPLASTS
J CELL SCI 14(1):29 74 34R

20. HEYN RF
RORSCH A SCHILPER. RA - PROSPECTS IN GENETIC ENGINEERING
OF PLANTS
Q REV BIOPH 7(1):35 74 R 92R

21. HOTTA Y
MIKSCHE JP - RIBOSOMAL-RNA GENES IN 4 CONIFEROUS SPECIES
CELL DIFFER 2(6):299 74 23R

22. KAMEYA T
EFFECTS OF GELATIN ON AGGREGATION OF PROTOPLASTS FROM
HIGHER-PLANTS
PLANTA 115(1):77 73 N 7R

23. KANAZAWA KI
IMAI A - PARASEXUAL-SEXUAL HYBRIDIZATION-HERITABLE
TRANSFORMATION OF GERM-CELLS IN CHIMERIC MICE
JAP J EXP M 44(3):227 74 33R

24. KAO KN
MICHAYLU. MR - METHOD FOR HIGH-FREQUENCY INTERGENERI
FUSION OF PLANT PROTOPLASTS
PLANTA 115(4):355 74 18R

Figure 5.8 (continued)

25. KAO KN
CONSTABE. F MICHAYLU MR GAMBORG OL - PLANT PROTOPLAST FUSION AND GROWTH OF INTERGENERIC HYBRI CELLS
PLANTA 120(3):215 74 17R

26. KARTHA KK
MICHAYLU. MR KAO KN GAMBORG OL CONSTABE. F
CALLUS FORMATION AND PLANT REGENERATION FROM MESOPHYLL PROTOPLASTS OF RAPE PLANTS (BRASSICA-NAPUS L CV ZEPHYR)
PLANT SCI L 3(4):265 74 26R

27. KAWASHIM. N
TANABE Y IWAI S - SIMILARITIES AND DIFFERENCES IN PRIMARY STRUCTURE OF FRACTION I PROTEINS IN GENUS-NICOTIANA
BIOC BIOP A 371(2):417 74 16R

28. KELLER WA
MELCHERS G - EFFECT OF HIGH PH AND CALCIUM ON TOBACCO LEAF PROTOPLAST FUSION
Z NATURFO C C 28(11-1):737 73 32R

29. MCCOMB JA
NEW TECHNIQUES FOR PLANT BREEDING
J AUS I AGR 40(1):3 74 170R

30. POIRIERH. S
RAO PS HARADA H - CULTURE OF MESOPHYLL PROTOPLAST AND STEM SEGMENTS OF ANTIRRHINUM-MAJUS (SNAPDRAGON) - GROWTH AND ORGANIZATION OF EMBRYOIDS
J EXP BOT 25(87):752 74 14R

31. PRAT R
(FR) STUDIES ON PROTOPLASTS .2. ULTRASTRUCTURE OF ISOLATED PROTOPLAST AND CELL-WALL REGENERATION
J MICROSCOP 18(1):65 73 67R

32. SAKANO K
KUNG SD WILDMAN SG - IDENTIFICATION OF SEVERAL CHLOROPLAST DNA GENES WHICH CODE FOR LARGE SUBUNIT OF NICOTIANA FRACTION 1 PROTEINS
MOL G GENET 130(2):91 74 9R

33. SCHIEDER O
(GE) FUSION EXPERIMENTS WITH PROTOPLASTS OF MUTANTS FROM SHAEROCARPOS-DONNELLII AUST
BIOC PHY PF 165(4):433 74 N 8R

34. SHARP WR
CALDAS LS CROCOMO OJ MONACO LC CARVALHO A
PRODUCTION OF COFFEA-ARABICA CALLUS OF 3 PLOIDY LEVELS AND SUBSEQUENT MORPHOGENESIS
PHYTON 31(2):67 73 17R

35. SMITH HH
MODEL SYSTEMS FOR SOMATIC-CELL PLANT GENETICS
BIOSCIENCE 24(5):269 74 104R

36. TAKEBE I
(JA) PLANT PROTOPLASTS-ISOLATION, ACTIVITY, AND APPLICATION
SEIKAGAKU 46(1):22 74 52R

37. UCHIMIYA H
MURASHIG. T - EVALUATION OF PARAMETERS IN ISOLATION OF VIABLE PROTOPLASTS FROM CULTURED TOBACCO CELLS
PLANT PHYSL 54(6):936 74 18R

38. USUI H
MAEDA M ITO M - HIGH-FREQUENCY OF SPONTANEOUS FUSION IN PROTOPLASTS FROM VARIOUS PLANT-TISSUES
BOTAN MAG 87(1006):179 74 N 6R

39. VASIL V
VASIL IK - REGENERATION OF TOBACCO AND PETUNIA PLANTS FROM PROTOPLASTS AND CULTURE OF CORN PROTOPLASTS
IN VITRO 10(1-2):83 74 58R

40. WALLIN A
GLIMELIU. K ERIKSSON T - INDUCTION OF AGGREGATION AND FUSION OF DAUCUS-CAROTA PROTOPLASTS BY POLYETHYLENE-GLYCOL
Z PFLANZENP 74(1):64 74 26R

Figure 5.8 (continued)

41. WIDDUS R
AULT CR - PROGRESS IN RESEARCH RELATED TO GENETIC ENGINEERING AND LIFE SYNTHESIS
INT REV CYT 38:7 74 R 282R

42. WINTON LL
PARHAM RA JOHNSON MA EINSPAHR DW - TREE IMPROVEMENT BY CALLUS, CELL AND PROTOPLAST CULTURE
TAPPI 57(12):151 74 N 8R

43. WITTWER SH
MAXIMUM PRODUCTION OF FOOD CROPS
BIOSCIENCE 24(4):216 74 R 134R

Figure 5.8 (continued)

Quick State-of-the-Art Search

Sometimes an exhaustive view of the literature is unnecessary; all that is needed is a quick review of the state of the art. Figure 5.9 shows a search, on the subject of hemoglobin binding, whose object is to identify papers that can provide a fast overview of the subject. The arbitrary criterion set for such papers is that they have more

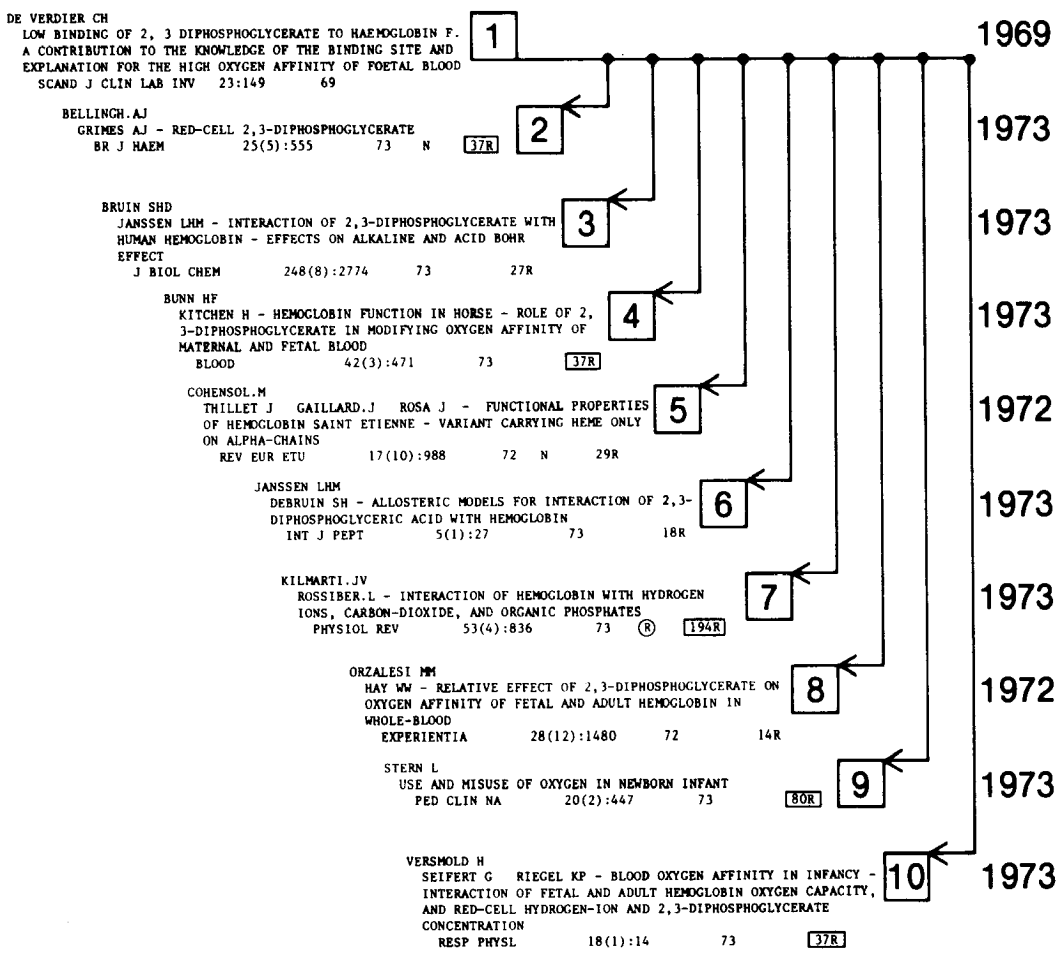

Figure 5.9 Quick state-of-the-art search.

than 30 references. The starting point for the search is a paper by C. H. De Verdier (#1 in Figure 5.9) from the researcher's reprint file. The 1973 *SCI Citation Index* identified nine papers on the subject. Five of them (#2, #4, #7, #9, and #10) are shown (see squares in Figure 5.9) to have more than 30 references. Their titles indicate that they are all relevant to the subject of the search. One of the five (#7) is identified as a formal review paper (see circle in Figure 5.9), and the others have enough references to make the researcher think they might be useful for review purposes.

Comprehensive Bibliography Search

The most exhaustive type of search is the one conducted to develop a comprehensive bibliography, which should provide a definitive look at the literature of a given subject. Normally, this type of search calls for the use of several indexes to achieve the degree of thoroughness required.

Figure 5.10 shows the first two cycles of a citation search to produce a bibliography on the subject of serum measurements of iron and ferritin and their roles in diagnosing pathological conditions. The search begins in the 1974 *SCI Citation Index,* with the citation of a paper written in 1965 by D. S. Young for the *Journal of Clinical Pathology* on a method for measuring serum iron. Eighteen papers are shown to have cited the Young paper. Nine of them (#3, #4, #5, #6, #11, #12, #13, #14, #18) appear from their titles to be relevant. In addition, each of them also provides, in its bibliography, reference citations on which the search can be continued through additional cycles.

For example, the paper by D. A. Lipschitz (#12) contains in its bibliography a reference to a paper by K. R. Reissman (#20). When the search continues on the citation for that paper, the 1974 *Citation Index* identifies five more papers (#21 through #25), three of which (#23, #24, and #25) have titles that indicate they are relevant.

The search can be continued in this way through as many cycles as is needed to

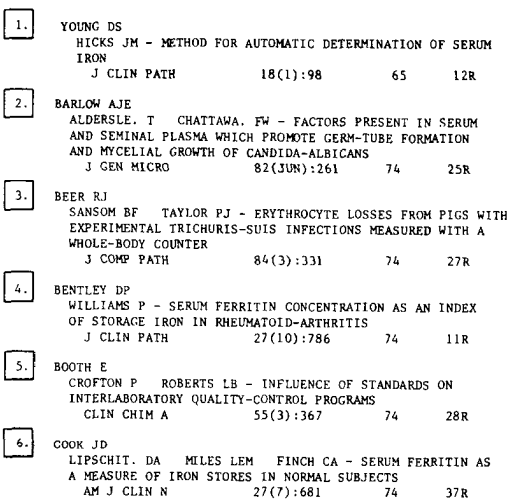

Figure 5.10 Development-of-bibliography search.

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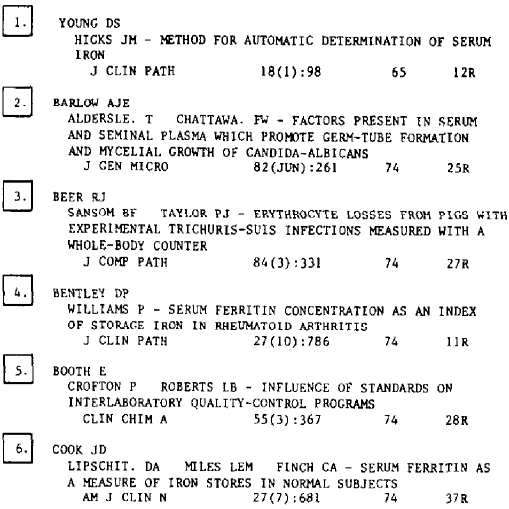

Figure 5.10 Development-of-bibliography search.

7. CRANE GG
JONES P DELANEY A KELLY A MACGREGO. A LECHE J -
PATHOGENESIS OF ANEMIA IN COASTAL NEW GUINEANS
AM J CLIN N 27(10):1079 74 39R

8. FLYNN FV
PIPER KAJ GARCIAWE. P MCPHERSO. K HEALY MJR -
FREQUENCY DISTRIBUTIONS OF COMMONLY DETERMINED BLOOD-
CONSTITUENTS IN HEALTHY BLOOD-DONORS
CLIN CHIM A 52(2):163 74 16R

9. KUMAR R
FERROKINETIC STUDIES - RED-CELL IRON UTILIZATION AND
RED-CELL IRON TURNOVER - IN ANEMIA OF CHRONIC INFECTION
I J MED RES 62(1):53 74 17R

10. LIEDEN G
ADOLFSSO. L - PHYSICAL WORK CAPACITY IN BLOOD-DONORS
SC J CL INV 34(1):37 74 18R

11. LIEDEN G
IRON STATE IN REGULAR BLOOD-DONORS
SC J HAEMAT 11(5):342 73 37R

12. LIPSCHIT. DA
COOK JD FINCH CA - CLINICAL EVALUATION OF SERUM
FERRITIN AS AN INDEX OF IRON STORES
N ENG J MED 290(22):1213 74 11R

13. MCCLEAN SW
PURDY WC - COULOMETRIC DETERMINATION OF SERUM IRON
ANALYT CHIM 69(2):425 74 16R

14. MEGRAW RE
HRITZ AM BABSON AL CARROLL JJ - SINGLE-TUBE TECHNIQUE
FOR SERUM TOTAL IRON AND TOTAL IRON-BINDING CAPACITY
CLIN BIOCH 6(4):266 73 9R

15. NAETS JP
WITTEK M - EFFECT OF STARVATION ON RESPONSE TO
ERYTHROPOIETIN IN RAT
ACT HAEMAT 52(3):141 74 12R

16. RAMSAY CA
MAGNUS IA TURNBULL A BAKER H - TREATMENT OF PORPHYRIA
CUTANEA-TARDA BY VENESECTION
Q J MED 43(169):1 74 36R

17. SKJAELAA. P
HALVORSE. S - DETERMINATION AND PHYSIOLOGIC EFFECTS OF
ERYTHROPOIESIS INHIBITORS
J LA CL MED 83(4):625 74 15R

18. SUMMERS M
WORWOOD M JACOBS A - FERRITIN IN NORMAL ERYTHROCYTES,
LYMPHOCYTES, POLYMORPHS, AND MONOCYTES
BR J HAEM 28(1):19 74 15R

19. WORWOOD M
SUMMERS M MILLER F JACOBS A WHITTAKE. JA - FERRITIN
IN BLOOD-CELLS FROM NORMAL SUBJECTS AND PATIENTS WITH
LEUKEMIA
BR J HAEM 28(1):27 74 15R

20. REISSMANN KR
DIETRICH MR - ON THE PRESENCE OF FERRITIN IN THE PERIPHERAL
BLOOD OF PATIENTS WITH HEPATOCELLULAR DISEASE
J CLIN INVEST 35:588 56

21. ESHHAR Z
ORDER SE KATZ DH - FERRITIN, A HODGKINS-DISEASE ASSOCIATED
ANTIGEN
P NAS US 71(10):3956 74 22R

22. LIPSCHIT. DA
COOK JD FINCH CA - CLINICAL EVALUATION OF SERUM FERRITIN
AS AN INDEX OF IRON STORES
N ENG J MED 290(22):1213 74 11R

23. MARCUS DM
ZINBERG N - ISOLATION OF FERRITIN FROM HUMAN MAMMARY AND
PANCREATIC CARCINOMAS BY MEANS OF ANTIBODY IMMUNOADSORBENTS
ARCH BIOCH 162(2):493 74 45R

24. MILES LEM
LIPSCHIT. DA BIEBER CP COOK JD - MEASUREMENT OF SERUM
FERRITIN BY A 2-SITE IMMUNORADIOMETRIC ASSAY
ANALYT BIOC 61(1):209 74 32R

25. UNGER A
HERSHKO C - HEPATOCELLULAR UPTAKE OF FERRITIN IN RAT
BR J HAEM 28(2):169 74 29R

Figure 5.10 (continued)

produce a definitive bibliography. Though the example is limited to searches of only the 1974 *SCI,* every citation used to search the literature of that year can be used to search the literature of the preceding years. You can go back as far as the oldest publication year involved—at least until 1961, when *SCI* starts. Such multiyear, cycling would produce a comprehensive bibliography of all the significant papers on the subject.

MACHINE SEARCHES

As with all other types of indexes, citation indexes can be searched by machine. Numerous organizations, including national and multinational information utilities, make the *SCI* and *SSCI* data bases available for this purpose. The advantage of machine searches is that the searcher is required only to supply the search instructions; the computer performs the lookups and prints out the results. This can be a very significant advantage on extensive searches, such as in the last example.

The strategy in machine searches is basically the same as in manual searches. Starting with a target document, the search identifies every paper that has cited the document. There are some variations on this approach in which the search is conducted on a set of target documents. One variation, developed by Schiminovich (6) for classifying a data base, but used successfully by Bichteler and Parsons (7) for retrieval, uses the bibliography of a paper considered representative of the subject of interest as the set of target documents. In another variation, Bichteler and Eaton substitute a custom-designed set of target documents (8) for an existing bibliography. They also rank the retrieved papers by the number of citations they have in common with the target set.

Many of the organizations that use the *SCI* and *SSCI* data bases for machine searches have extended their utility beyond retrospective search into the area of current awareness. The *SCI,* in fact, was the basis for the first commercially available selective-dissemination-of-information (SDI) service for monitoring the current literature on a personalized basis. Called *ASCA* (9), an acronym for *Automatic Subject Citation Alert,* this service searches each weekly addition to the *SCI* data base for papers that match the interests of subscribers. Subscriber interests are specified in what are called "profiles." *ASCA* profiles include both source- and reference-type search terms. One may wish to be informed as to what is being published in given journals, or one may want to know what a given organization or author is publishing. The search can also involve screening article titles for specific subject terms, word phrases, or word stems. In addition to these source-type questions, that is, questions based on the citing work, one can search for material that cites given authors or published works. Thus, *ASCA* profiles can include cited-author, cited-book, cited-journal, or cited-article search terms. The ability to identify material by these citation linkages is an important and unique feature of the service (10). In fact, it has been so useful as a technique for monitoring the literature that a majority of the research organizations and libraries that use the weekly *SCI* computer tapes do so much more often for current-awareness purposes than for retrospective searches.

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