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RESOURCE REVIEW

Web Resources for Stem Cell Research

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Abstract In this short review, we have presented a brief overview on major web resources relevant to stem cell research. To facilitate more efficient use of these resources, we have provided a preliminary rating based on our own user experience of the overall quality for each resource. We plan to update the information on an annual basis.

Introduction

Stem cell research is at the frontier of regenerative medicine [1–3]. To avoid the ethical issues related to the use of embryonic stem cell (ESC) or somatic cell nuclear transfer (SCNT) technology, induced pluripotent stem cell (iPSC) technology has been developed and matured in recent years [4,5]. Fibroblast and other types of terminally-differentiated cells can be reprogrammed into iPSCs using defined factors. iPSCs can be further differentiated into various tissues using tissue-specific inducing factors [6]. Differentiated cells can also be directly converted to other types of differentiated cells (also termed "trans-differentiation") [7]. To foster the fast development in this field, several databases and web servers have been established in the past few years (**Figure 1**). Relevant literature and high-throughput experimental data have been curated. Available data analyses range from identification of physical interactions and regulatory partners to enrichment analysis and network construction. Here, we provide a brief overview of these web resources. Based on our own user experience of the overall quality of the resources, we have provided a preliminary rating for those resources (**Table 1**). The rating is mainly based on: (1) how many types of data have been included? (2) how many samples or high-throughput experiments have

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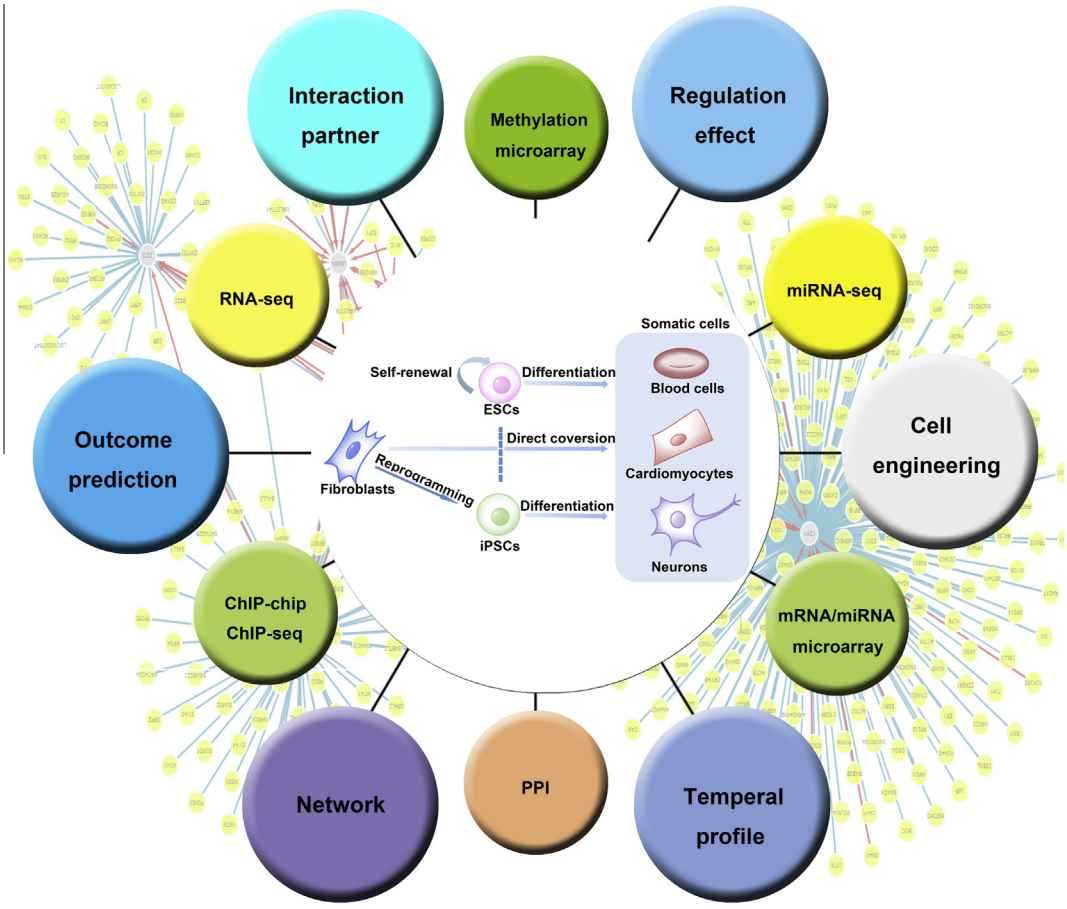

Figure 1 Integration of high-throughput data in stem cell research

In order to achieve better understanding on reprogramming, direct conversion, self-renewal, and other processes in stem cell biology, genome-wide profiling have been conducted at the end points and sometimes during those processes. Various types of high-throughput data have been collected and integrated in over a dozen of specialized web resources. The relationship among critical genes can be visualized in a variety of ways. Shown on the background is a network generated by StemCellNet.

been included? (3) what kind of online data analysis is available? (4) is the web interface user friendly? and most importantly, (5) can we gain any novel insight by using the web tool?

CellNet

Among the available web resources, CellNet is the most practical tool for somatic cell reprogramming and direct conversion [8]. Analyses on the gene regulatory network (GRN) have been conducted on 20 mouse cell lines or tissue types and 16 human cell lines or tissue types, and several characteristic GRN modules have been identified for each cell line or tissue type. The main aim of CellNet is to facilitate cell engineering, not limited to stem cell biology. User-uploaded gene expression profiles are compared with the benchmark profiles, and three types of analysis results can be obtained. The first is cell and tissue type classification, basically indicating how close the engineered cell is to any of the benchmark cells or tissues. The second is the GRN status, *i.e.*, the evaluation of the establishment of the characteristic GRN modules for intended target cell or tissue. The third is the network influence score. For each of the critical transcriptional regulators of the intended target cell or tissue, the distance to the expected expression level will be calculated and the top 50 down-regulated regulators will be highlighted. Overall, CellNet provides a practical guide to fill the gap between the engineered cell and the intended target. Although CellNet is not specifically designed for stem cell research, this unique application on cell engineering is the main reason we gave it a 5-star rating.

LifeMap

LifeMap contains a large collection of the literature and gene expression data relevant to stem cell differentiation, embryonic development and regenerative medicine [9]. Information is available for cell types including ESCs, iPSCs, embryonic progenitor cells, adult stem cells, primary cells, and fully-differentiated somatic cells from human and mouse. Retrievable information include gene expression, signaling pathways, cell types, developmental stages, anatomical compartments, differentiation protocols, diseases, cell therapies, and literature references. Illustrative and interactive images are provided for better user experience. LifeMap is more like an encyclopedia for embryonic development and regenerative medicine. The main highlights include comprehensive curation of both